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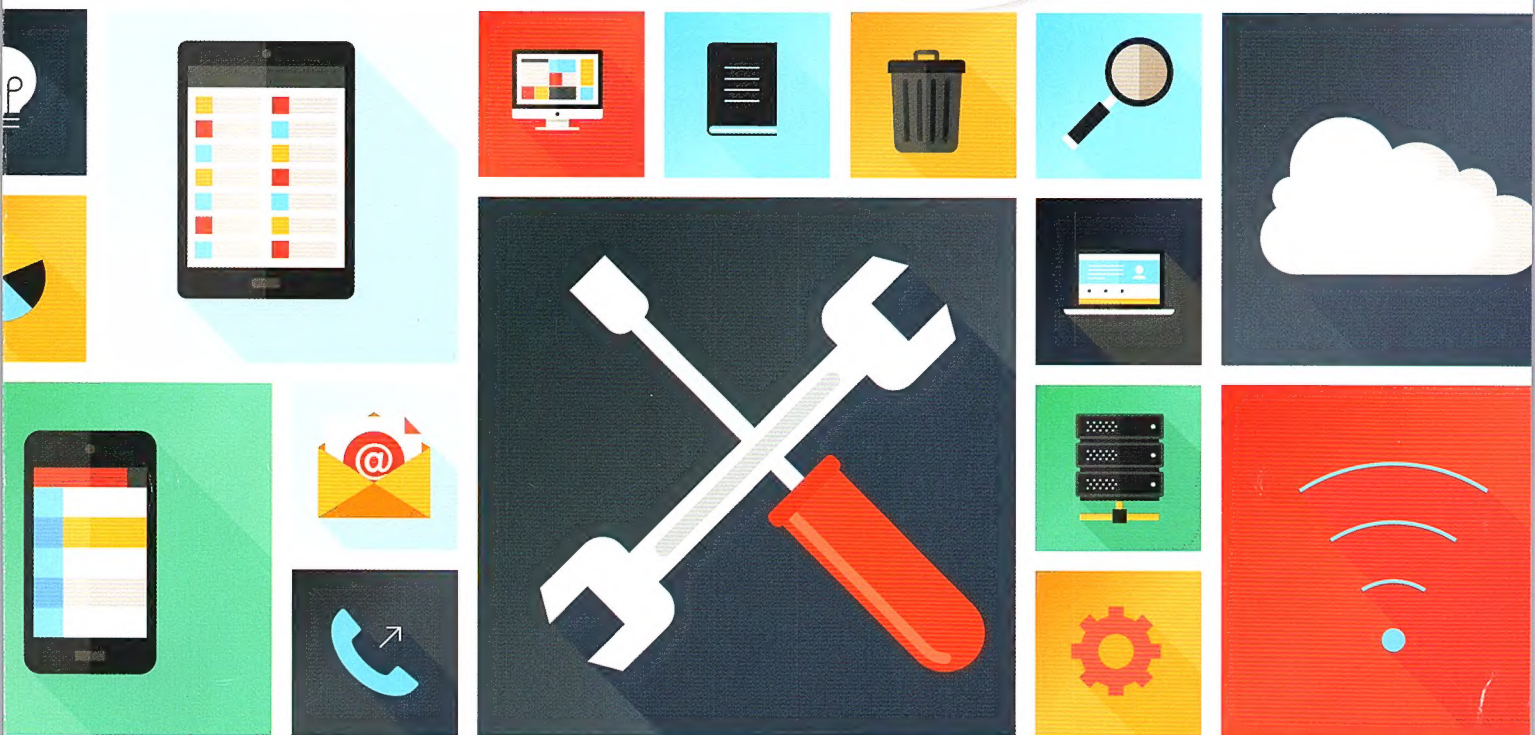
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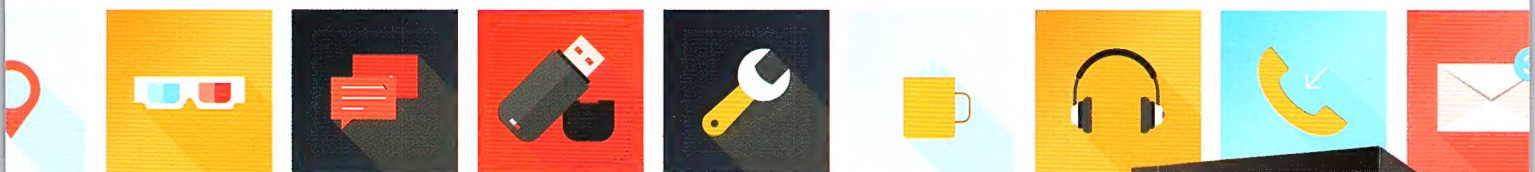
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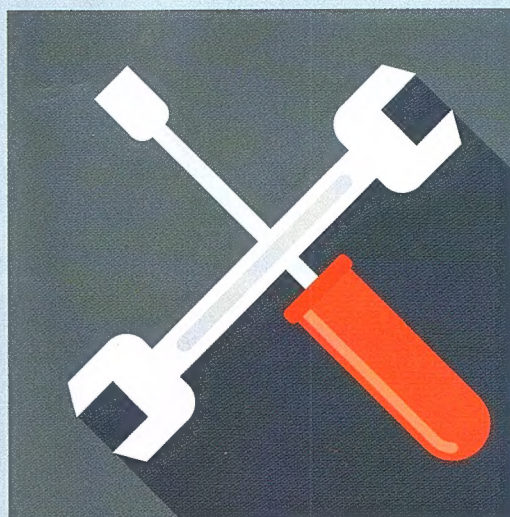
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Essential PC know-how

Anyone can learn to fix their PC problems by understanding the basics, says APC's editor.

Here at APC, it should come as no surprise that we love the PC – and if you're reading this, we reckon there's a fair chance that you do, too. Unfortunately, loving the PC is a bit of a double-edged sword – largely because it means being tech support for friends and family who, perhaps, don't share that same level of adoration.

This month's cover feature aims to strip back the wallpaper on those and uncover at least some of that mystical know-how, so that anyone – no matter what their level of PC skill – can troubleshoot their own PC problems. And whether you're a life-long geek or a relative newcomer to building and fixing PCs, we hope you find some new and useful tricks and techniques here. (And hey, even if you're a PC guru that already knows all of them, you can at least pass this issue on to a friend or family member that doesn't – which should mean less tech support time for you!)

ALSO IN THIS ISSUE

Of all Windows 8's sins, there's been a lot of understandable grumbling about how messed up its pro-level audio support is – we've had several readers write in to us about it – so it's unsurprising that people are looking for alternatives. The Mac is probably the most obvious choice if you're looking to jump ship, but what's perhaps unexpected is that

Linux has fairly good audio-production chips, too. If you're an audio dabbler – or a pro that's still sticking with an older version of Windows – then our feature on using Linux for music production is definitely worth a look. And in a broader sense, it demonstrates yet again how versatile Linux is as an operating system.

NEXT MONTH: ULTIMATE UPGRADES + 2015 TECH PREVIEW

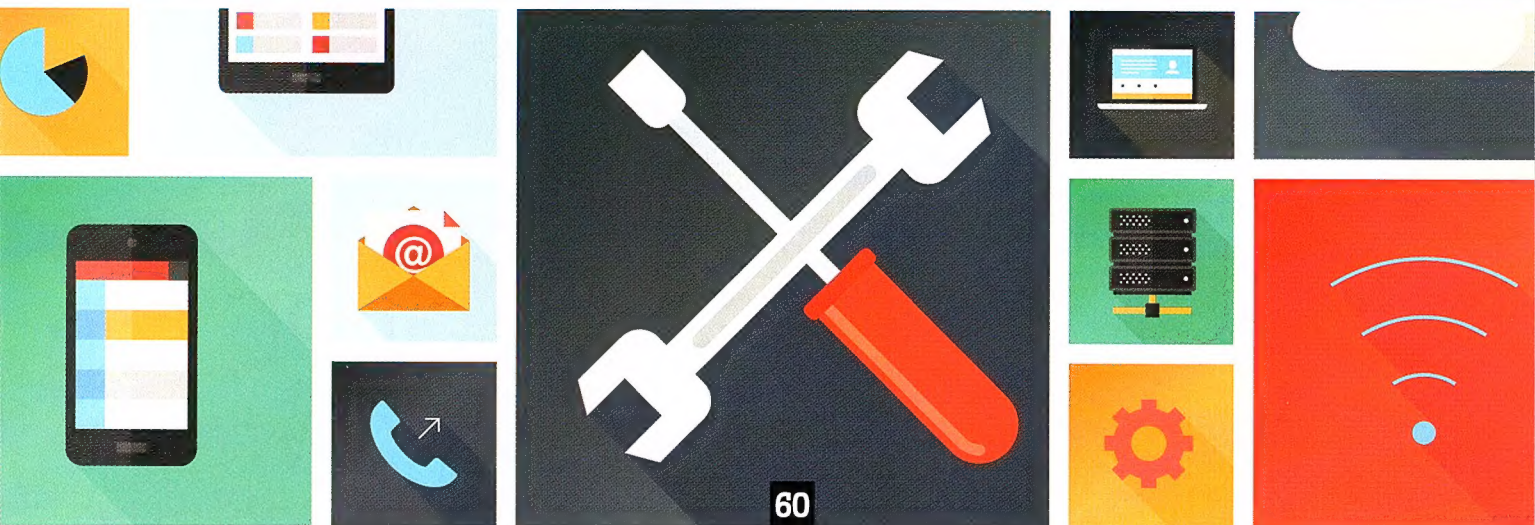
As is always the case, the last 12 months have seen a bevy of new PC tech unveiled (and in some cases, that description would better be adjusted to say 'unleashed'), but this also means it can be hard to know what among all this new gear is worth upgrading to. In the February edition, we'll tackle this question, addressing all the core components, so you can find the sweet spots for upgrading your rig, or building a new one. And with 2015 getting underway, we'll also take a sneak peek at what changes are coming to all the major PC parts too!



DAN GARDINER
EDITOR-IN-CHIEF
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History's biggest hack

Did North Korea take down Sony Pictures in retaliation for Kim Jong-un assassination flick? Stephen Lambrechts

Sony just can't catch a break when it comes to its cyber security. The corporation's film and television arm, Sony Pictures Entertainment, has been hit with a cyber attack that many are predicting will end up as the biggest corporate hack of all time.

Since late November 2014, tens of terabytes of private Sony Pictures data has been stolen and made agonisingly public, with personal details for over 40,000 current and past employees revealed. That includes information such as employee salaries, private emails, social security numbers and negative employee feedback. Celebrity phone numbers, home addresses and aliases are also up for grabs. Other uncovered items include actor popularity polls, unreleased scripts and various legal claims against the company. So what's the catalyst for this

unprecedented assault? Funnily enough, it all begins with an upcoming comedy – *The Interview*, starring Seth Rogen and James Franco. In the film, the duo play a talk show team recruited by the CIA to assassinate North Korean leader Kim Jong-un.

Predictably, many North Korean sympathisers don't find the film's premise funny. The group behind the attacks, known only as GOP, has demanded that *The Interview's* release be stopped, declaring it an "act of war".

Evidence points to North Korean involvement, with the breach using malware code written in Korean that's quite similar to code used against South Korea last year. North Korean country officials recently appealed to the United Nations to have the film banned, making that theory quite convincing.

The country's National Defence Commission, however, has officially

denied any involvement in the breach... which isn't to say that it's not glad it happened. A spokesman called the act a "righteous deed" and suggested that North Korean "supporters and sympathisers" from around the globe might be behind it, in an effort to "put an end to US imperialism".

After a group claiming to be affiliated with GOP went on to make terrorist threats – posting a document on **Pastebin.com** telling people to "remember the 11th of September 2001" and warning them to stay away from theatres showing the film – most major cinema chains in the US have declined to show the picture, a move which led Sony to cancel its official December 25th theatrical release. At the time of print, it was speculated that the film could see an online video-on-demand premiere – which'd make it the first major picture to debut on the web.

Windows 10 release date gets a little firmer

Redmond's next OS set to land mid-to-late 2015.

Since its official announcement in late September last year, details on Microsoft's release plan for Windows 10 have been vague at best. Thankfully, recent comments made at a Credit Suisse Technology Conference by Microsoft's Chief Operating Officer Kevin Turner have shed a little more light on its roadmap.

Turner told conference attendees that Microsoft will "talk about the end-user experiences" in the early autumn of 2015, and that it will release a developer preview by early winter.

"And then by late winter and early spring, we'll be able to bring out this particular OS. That's the current plan of record," said Turner.

In related Windows 10 news, it's emerged that Master Chief's A.I. sidekick Cortana (of the *Halo* game series) will likely be making her digital assistant desktop debut in the upcoming OS. Cortana will function much like her current Windows Phone iteration, with early previews indicating the digital PA will reside in a dedicated search icon or search bar (depending on your setup) on the taskbar. She'll be designed to help users launch apps, call people on Skype, set reminders, check the weather, play music and much more.

Stephen Lambrechts



Has the Pirate Bay finally walked the plank?

The "galaxy's most resilient BitTorrent site" bites the digital dust.

Launched way back in 2003, the Pirate Bay has been a virtual dreadnought in the online file-sharing landscape, weathering numerous assaults and providing a beacon for free media — and outright piracy — for millions of users worldwide.

On December 10th, 2014, the Pirate Bay suddenly went down amid speculation of a technical error. But after more than a day of inactivity and reports of police raids on the site's compound in Stockholm, it was revealed that there was more to the outage than just missing code.

At least one member of the Pirate Bay's Swedish staff has been arrested and Swedish government officials have confirmed that they have seized a number of its servers.

Peter Sund, one of the site's creators, surprisingly responded to the news by saying he believes the Pirate Bay's heyday has been and gone. Recently released from prison for matters relating to the site, Sund wrote on his personal blog that the Pirate Bay had become an institution and he felt good about its closure, as it would perhaps make way for a fresh start. "But from the immense void that will now fill up the fibre cables all over the world, I'm pretty sure the next thing will pan out," wrote Sund, hoping that it would soon be replaced by "something new, something better, something faster, something more reliable and with no chance of corrupting itself." Joel Burgess



Intel merging PC and mobile divisions

Wants to make one chip to rule them all?

The last few years have seen tech generally trending towards bigger smart phones and more powerful tablets — a focus that's arguably making the distinction between platforms smaller by the day.

Brian Krzanich, the chief executive of chip-making giant Intel, seems to be thinking the same thing. In a November email to his employees, Krzanich revealed the company's plans to merge their current PC and mobile/tablet divisions by mid 2015.

Intel's PC chip division has maintained a strong position in the market for some time, but its mobile arm isn't doing so rosily, posting a loss

of US\$1.04 billion in the last quarter, with similar results in the preceding period. Though Intel is on track to ship its annual target of 40 million mobile chips, this has largely come from generous subsidies for device makers, where Intel picks up the tab for any unsold devices.

Intel Spokesman Chuck Malloy explained that the company needs to move faster in the mobile market if it's going to be competitive. "The lines are blurring between PCs, tablets, phablets and phones," said Malloy. "The idea is to accelerate the implementation and create some efficiency so that we can move even faster."

Joel Burgess

Lost in (Google) translation

France takes aim at US tech companies.

Less than a month after launching in France, Netflix is being sued for contracts that contain "malicious and illegal" clauses. These include changing the terms of the agreement without due notice and contracts that are only available in English. France also has a growing list of grievances against Google. Coming off the back of European internet privacy security fears that embroiled the search company earlier in 2014, the French government is investigating Google over accusations it owes more than a billion Euros in back taxes and fines. Some of these fines relate to the "right to be forgotten" litigation, which makes search engines responsible for the removal of any outdated and inflammatory material in France. The onslaught continues all the way to the European Parliament, which voted to "unbundle" search engines from business enterprises in November. Worried about how foreign search engines rank European companies, politicians are pushing for search engine independence from advertising revenue. JB



300m

Pics now worth more than 160 characters?

Photo-sharing service Instagram has revealed that after only 4 years, the platform now consists of 300 million regular users. Twitter, by comparison, only has 284 million users, despite having been launched 8 years ago in 2006. Instagram reports that it sees 70 million photos being shared each day on the site, with 70% of its web traffic coming from outside the US.

48,819

Target's decision to pull GTA V creates controversy amongst gamers.

In an event that forced many to question the right for freedom of speech versus what's seen as morally right, Australian retailer Target recently announced the removal of R-rated video game *Grand Theft Auto V* from its shelves, following a petition that gained over 48,819 supporters. While the game was officially released last September, it was only in November this year that a Change.org petition was created by three women who claim to be survivors of violence. The group believe that the game encourages violent acts towards women, including physical and sexual violence. The petition quickly gained support, and after only five days Target had announced the removal of the title from its shelves. The company's decision created a massive controversy amongst Australian gamers, many of who believe Target's actions were an overreaction. While the game does encourage violence, women aren't specific targets; violence can be inflicted on almost any individual, even random passers by, within the game. Soon after Target's decision, Kmart also followed suit, stating that it too was removing the game along with all other *Grand Theft Auto* titles.

25

Drones becoming an increasing flight risk

The Federation Aviation Administration, responsible for regulating airspace in the US has released data revealing that it receives roughly 25 reports of drones flying dangerously close to aircrafts every month. The data come from pilots who report sightings of drones while flying, often seeing them fly well above the legal limit of 120 metres. While US laws require drones to be flown away from airports and obviously avoid traditional airplanes, the report reveals that a number of pilots have been forced to alter their flight path in order to avoid a potential collision — something that can be catastrophic, even from an object as small as a drone.

US\$200.10 +400%

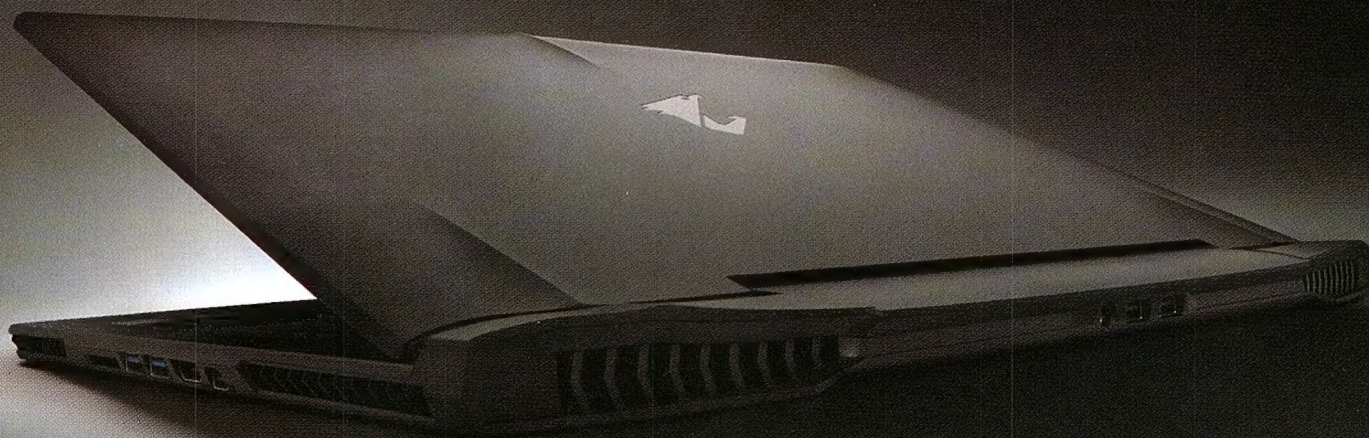
What are you actually paying for when you buy a smartphone?

While Apple might promote itself as creating products that feature leading edge technology, it may surprise you to learn that the cost to produce the cheapest iPhone 6 is a tiny US\$200.10. With the iPhone 6 officially selling in the US for \$649, this represents a whopping 69% profit margin, with the larger 6 Plus similarly featuring a 71% markup. The biggest expense for the device is the internal battery, costing Apple US\$45 for the iPhone 6 and US\$52.50 for the 6 Plus. Of course, what that data doesn't include is the amount Apple spends on things like R&D, marketing and software development — things that can contribute significantly to the phone's overall cost.

Government responds to pleas for change, says media landscape requires new legislation.

Following an investigation, consumer group CHOICE has found that Australians are being charged up to 400% more for subscription TV content. Similar results were found in online stores such as iTunes (up to 261% more) and Google Play (291% more). This coincides with the Australian Government's recent announcement for plans to introduce new copyright laws that will see popular pirating web sites blocked for Australian users, while at the same time ensuring that those who do download illegal content aren't punished criminally. Rather than throttling the internet speeds for repeat offenders, for example, the government instead plans to provide written warnings to explain the consequences of their actions.





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technotes

» GEAR WE WANT



JAWBONE UP3

\$230 | JAWBONE.COM/UP

Continuing its ever-expanding line of fitness trackers, Jawbone has announced its UP3 which adds a slew of new monitoring capabilities, like bioimpedance sensors able to track things such as skin temperature, respiration and even resting heart rate. Like its UP24 predecessor, the band's is also able to detect the different stages of sleep, with a vibrating alarm able to wake you at your most optimal point in your sleep cycle. The mobile app is full-featured and connects with your device via Bluetooth, with the app using the data to provide personalised goals and tips, theoretically motivating you towards better health. The UP3 is fully water resistant up to 10 metres, with the device promising a battery life lasting up to a week. While an exact release date hasn't been announced, Jawbone promises that it will be out sometime this summer. **TB**

PUZZLEPHONE

\$TBA | WWW.PUZZLEPHONE.COM

While most APC readers love a good DIY project, today's manufacturing techniques mean that most products are mass-produced and non-customisable. Finnish company Circular Devices is attempting to change all that with the Puzzlephone. While still in early development, the phone is made so that the hardware is divided up into three modules – the 'brain' which houses the processor and the camera, the 'heart' which holds the battery, and the 'spine' which consists of the LCD screen, speakers and home button. The premise of the device is that it's highly customisable, with each module able to be repaired or upgraded without the need for the entire phone to be replaced. For example, a photographer could upgrade the camera lens to one of a higher quality, while a cracked LCD screen could be quickly replaced with a new module. Designed to operate on Google's Android operating system, the company hopes to release the phone by the end of 2015. **TB**



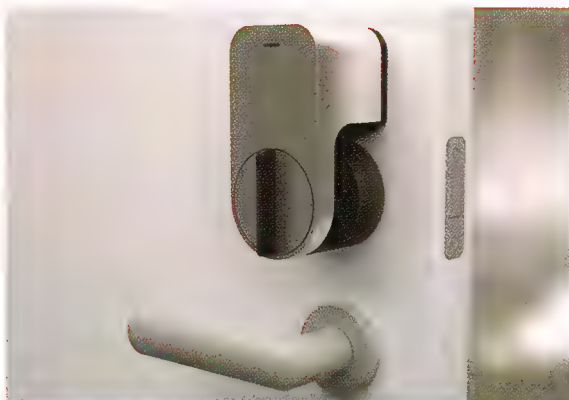
SONY PLAYSTATION 4 20TH ANNIVERSARY EDITION

US\$499 (SOLD OUT) |

AU.PLAYSTATION.COM

Those of us who are crippled by nostalgia may have quite a difficult time resisting the allure of Sony's new 20th Anniversary PS4, which sports the classic grey styling and multi-coloured logo of its first ever video game console... but spotting a unicorn might be easier than getting your hands on one of these beauties. As awesome looking as the retro-tinged console is, the decision of whether you should buy one has pretty much already been taken away from you, with the one-off batch of 12,300 units selling out within minutes. Then again, you could always spend upwards of US\$20,000 if you're really serious; that's the price one of the consoles recently sold for on eBay. **SL**





SONY QRIO SMART LOCK

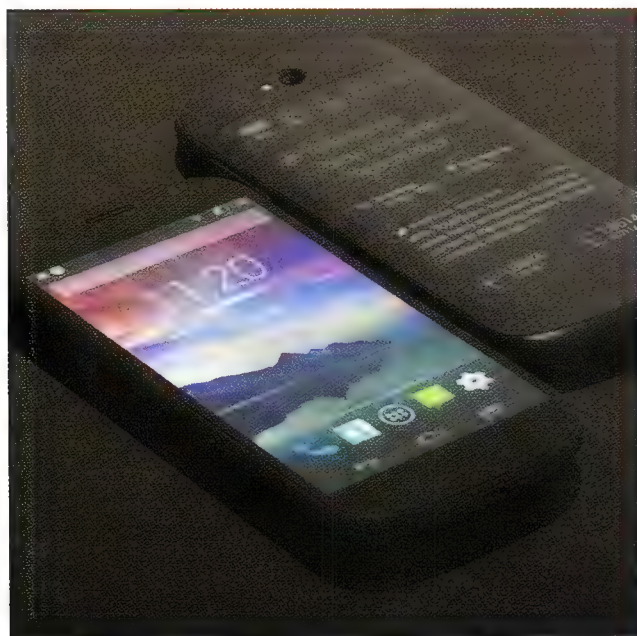
US\$130 | MAKUAKE.COM

Launched by Sony on Japanese crowd-funding web site Makuake, this smart lock is expected to retail at around US\$130, making it the most affordable on the market. Granted, recent stories of Sony's server hack likely won't help instil confidence in its ability to oversee a home security system – and the Qrio isn't even the first of its kind – but there is something intrinsically satisfying about the backing of a big brand when it comes to being able to open a door with your phone. As with other smart locks, the benefits include being able to share encrypted keys with friends and family (saving the hassle of getting keys cut) and you can even let people into your abode without leaving the couch. Now Sony, let's talk about making a robot that can get me a beer. **JB**

SPHERO OLLIE

\$150 | WWW.GOSPHERO.COM

The creators of Sphero, the rather awesome programmable smartphone-controlled ball, are rolling back onto the scene – this time with a cylinder. Ollie is a polycarbonate tube roughly the size of a soft-drink can, with two independent wheels that zip it around at a speedy 22 kilometers per hour. (The only thing that moves faster through the house is your freaked out cat.) Ollie connects to a downloadable app (available for Android and iOS) that has a simple interface, gestural recognition and a dedicated trick mode. Built-in colourful LEDs, a 30 meter maximum range and a one hour battery life make this the modern equivalent of kicking a can down a street – if perhaps a wee bit more awesome. **JB**



YOTAPHONE 2 — PHONE AND E-READER IN ONE

£555 | YOTAPHONE.COM

With e-ink readers like the Kindle becoming increasingly popular, the makers of the YotaPhone 2 have retooled the ebook technology to create a rather unique Android handset. The company promotes this phone as being the world's first smartphone with two screens. There's a typical 5-inch 1080p AMOLED display on the front, and a 4.7-inch e-ink display on the back. This always-on e-ink display features a capacitive touchscreen, enabling users to see and interact with notifications and other information without needing to unlock the phone proper. That e-ink display also improves battery life, with the company promising up to five days of reading on a single charge. Developers are able to create apps specifically designed to interact with the e-ink display, with YotaMirror also enabling any Android app to appear on the back screen – albeit in black and white. Users won't, however, want to use the e-ink as the primary display – with typical issues of e-readers being present, such as lag when interacting with the screen. The phone is also quite costly, the high price being necessary to compensate for the additional screen. **TB**



"PCs play almost every major-release game and a lot more great indie ones on top. Sure, we miss out on some exclusives, but then the PlayStation misses out on Xbox games and vice versa."

PCs AREN'T DEAD!

In response to Ashley Reid's letter in APC December, you say the flaw with PC gaming is that it won't play Xbox or PlayStation games. In most cases, this is wrong; PCs play almost every major-release game and a lot more great indie ones on top. Sure, we miss out on some exclusives, but then the PlayStation misses out on Xbox games and vice versa. If I was to go by your logic, I would pay well over a thousand dollars to play a few exclusive titles. As for multiplayer in one room, it's actually really easy to hook up multiple wireless controllers to a PC and be comfortable without having to be anchored to a desk. One example is to hook it up to a TV with a wireless keyboard and mouse, which is what I've done.

You say it ultimately comes down to the games? You're right. On PC, you can get access to thousands at the click of a mouse. Now factor in the cost somebody would already spend buying both a computer and a few consoles.

Other people's decision to game on PC doesn't effect you personally, so why the argument? Either you're trying to stir the pot with your own opinion, but there is no 'right' one when it comes to opinions! Either that, or you find enthusiast 'geekwank' PCs

(as you described them) out of your price range. Pick a reason, why does this bother you? When games will always be made on PC, PC gaming is not going anywhere.

Dean Arndt

SELL! NO WAIT, BUY!

I refer to a Quick Tips letter in APC November 2014 from Iain McGreevy about keeping stock market records. I too dabble in stocks and use a relational data base program that Iain may be interested in.

I use a program called Foxpro for Windows v2.6a. It's from 1994 but is still a very good program and is a free download from vetusware.com in the DBMS section.

It's like programming in BASIC but much more powerful. You can set up a relational database for up to 25 individual files. I get free monthly stock market data from www.afmrmartinvestor.com.au/share_table/ (Securities, Sectors, Dividends declared) and get daily stock data from commsec.com.au. I use this data to set up files and can get a lot of information at the click of a few buttons. I currently have 1.5 million daily data records in my file for the last 3 years. My shares folder is currently about 520MB.

The program is from days when computer power was much more limited and should be OK for even older computers.

Bent Pedersen

WHAT WERE THEY THINKING?

Who at Microsoft had the bright idea to try and compete with Android in the ultra cheap tablet market by allowing manufactures to produce Windows tablets with 7-inch displays with resolutions of less than 1,280 x 800-pixels and only 16GB of storage?

A resolution of 1,280 x 800 won't allow some of the basic preinstalled programs (such as Mail and the PDF reader) to run. Plus, 16GB of storage is insufficient to run Windows. Once you install Office 365 (which often comes with these tablets) there is only 2GB of free space, even after all the Windows data folders are moved onto the SD card. This is not enough space to install extra apps and allow headroom for updates and temporary files.

Some people might buy these tablets, but if this is their first experience of a Windows tablet I don't think they'll ever buy one again!

Carl Francis ■

APCMAG@FUTURENET.COM

Come on, have your say!

We want to hear what you think. Add to these discussions or email your views (in fewer than 250 words) to apcmag@futurenet.com. All correspondence becomes the property of APC and is subject to editing. Letters must include full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.



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#jumpstart

Do professional reviews still matter?

Everyone on the internet has an opinion to share, but does that mean we should listen to them? Stephen Lambrechts

Anyone who has ever spent a decent chunk of their paycheck on a product has likely consulted a review of it beforehand. How else are we supposed to know if a game is worth owning, or if a phone is worth being locked into a contract over? No one wants to be saddled with a dud product, which is why reviews are instrumental in our decision making process.

Reviews have the power to directly impact sales and company stock prices. Developers are also effected by how a product rates, with employment contracts tied to metacritic scores.

While we've always looked to professional analysis of products in the past, the internet age has given everyone a voice. The question is: how are we supposed to know if that voice is trustworthy? Reading user reviews can be a wonderful way to navigate the many different consumer reactions to a certain product. However, any consumer that purchases and then reviews a product is financially and emotionally invested in it, which can compromise that person's ability to form an objective opinion. Feelings of disappointment or satisfaction become magnified, which is how we end up with polarised user reviews.

How often have you read an irrationally-angry user review, followed by an overwhelming positive one? How can you decide which review is more accurate?

Of course, not all users have spent their own money on the item they're



[See the trailer](#)



Metascore
Generally favorable reviews
based on 86 Critics

[What's this?](#)

Summary: Diablo III picks up the story twenty years after the events of Diablo II. Mephisto, Diablo, and Baal have been defeated, but the Worldstone, which once shielded the inhabitants of the world of Sanctuary from the forces of both the High Heavens and the Burning Hells, has been destroyed, and... [Expand](#)

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User Score
Generally unfavorable reviews
based on 9196 Ratings

Your Score 0

Developer: Blizzard Entertainment

Genre(s): Action RPG

Cheats: [On GameFAQs](#)

Rating: M

[More Details and Credits](#)

Critic Reviews



User Reviews



[Write a Review](#)

reviewing. With reports of YouTube personalities getting early access to games and even payment from game companies in exchange for positive comments, the concept of the user review loses another layer of credibility.

When it comes to reviews, it's important to know the source. Professional reviewers are bound by the integrity of the publication they write for and by their own journalistic values to objectively approach each review. When you read a professional review in a magazine or on a respected web site, you can trust that the opinion in question is backed by the publication it's appearing in. A publication will spend many years earning the trust of its readership, and while almost no review can be 100% objective, that doesn't mean we shouldn't be

continually striving to reach that level.

With that in mind, we point you to APC's policy regarding reviews: "Our review policy at APC is one of strict editorial independence. We don't accept remuneration for positive coverage and we deliberately try to firewall our reviewers from any advertisers. This means that while you may see advertisements for products we've reviewed in APC, in most cases the journalist conducting the review won't have any knowledge of advertising arrangements."

Nevertheless, we'd suggest approaching all reviews — whether online or in print — with a critical eye. And in the same vein, if you're writing online reviews yourself, it's probably worth turning that eye back around to examine your own biases, too. ■

ENDUSER

Share your stories!

If you have an interesting story about technology users, their experiences and the issues that affect us all (whether funny or serious), email us at apcmag@futurenet.com. All correspondence becomes the property of APC and is subject to editing. Letters must include writer's full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.



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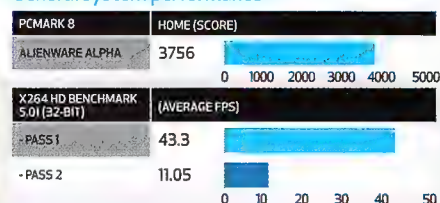
"Alienware's shipping the Alpha with an Xbox 360 wireless controller and matching USB receiver dongle; there's no keyboard or mouse whatsoever."

LOUNGE ROOM PC

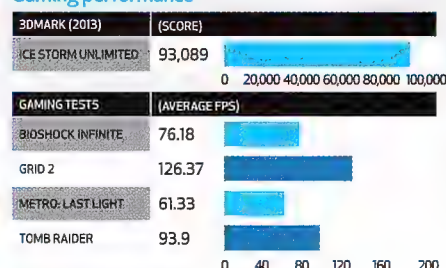
\$1,299 | ALIENWARE.COM.AU

LABS BENCHMARK RESULTS

General system performance



Gaming performance



* ALL GAMING TESTS PERFORMED AT 1080P WITH MEDIUM DETAILS.

Alienware Alpha

The lounge-room friendly Steam Machines have arrived! Are they any good?

For pretty much all of 2014 (and half of 2013), the APC team has been looking forward to the arrival of the first Steam Machines. Billed as the PC alternative to a games console, these compact, lounge-room friendly boxes will run Valve's SteamOS and are controlled with a gamepad.

Events have conspired to hold most of these Steam Machines back, with the official release date of the Linux-based SteamOS postponed until sometime later this year, and the Valve-developed Steam Controller still going through redesigns. The latter, it's hoped, will rival mouse and keyboard for playing both twitchy games, like first-person shooters, as well as pointer-driven affairs like strategy titles.

Still, those setbacks haven't stopped Alienware — undoubtedly the biggest backer of the Steam Machine concept — from having an early crack at making one anyway. And it's

a surprisingly respectable unit, using a mix of desktop and laptop parts to create a compact PC-gaming box that's 20cm to a side and 8cm tall — smaller than any current games console.

There's no optical drive, but you do get four USB ports (two 2.0 in front and two 3.0 round back), HDMI 1.4a and optical-audio outputs (plus an HDMI input for passthrough), Gigabit Ethernet and 802.11ac Wi-Fi. Alienware's shipping the Alpha with an Xbox 360 wireless controller and matching USB receiver dongle; there's no keyboard or mouse whatsoever.

The Alpha has basically two discrete modes of operation — Console mode and Desktop mode. By default, it boots straight into Console mode, which sports a custom Alpha UI that's designed to be driven by a gamepad; it's largely there to let you tweak hardware settings before launching into Steam's Big Picture mode which, similarly, is made for pads.

To get to Desktop mode — which makes the Alpha run like a regular Windows 8.1 PC — you need to navigate into the Alpha UI's Power menu to log out of Console mode and into Desktop. Note, though, that the menu option to do so will only appear if you have a keyboard plugged in. It should be clear, then, that Alienware's taken care to ensure that — barring crashes or errors — Console mode is sufficiently locked down that you shouldn't ever need to reach for a keyboard and mouse. Even if you never boot into Desktop mode, basic system housekeeping still gets done. Windows Updates are automatically installed when you reboot — and the Alpha UI has a small alert down the bottom left letting you know when these are available.

The core hardware in this top-end model — a low-power desktop Core i7-4675T CPU along with what we suspect is an Nvidia GeForce GTX 860M GPU

(Alienware won't specify the exact part) and 8GB of memory — is enough to run most games at above 60fps on the High details setting at 1080p. For demanding titles like *Metro: Last Light* you may need to drop that to Medium details, but it's the exception.

Are there shortcomings? Yes, certainly. At the time of press, you were beholden to Alienware to provide GPU driver updates and, rather annoyingly, there's no way to play back videos in Console mode — meaning you need to exit to Desktop mode — and have a mouse and keyboard — for that.

■ Dan Gardiner

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

An odd mix of desktop and laptop in a compact package, but one that works well for PC gaming from the couch.





BUDGET LAPTOP

\$299 | HP.COM/AU

HP Stream 11

Microsoft and HP team up to take on the Chromebook.

OK. Now, we know this laptop's striking pink/purple colour scheme probably has some readers recoiling in horror, but before you hastily flip the page, we have some good news: HP's Stream 11 is also available in a slightly more sedate bright blue, too.

This exceptionally low-priced 11.6-inch unit is basically Microsoft's answer to the slow rise of Chromebooks. HP's managed to get the price so low in this one by running Microsoft's new free-to-license version of Windows, called "Windows 8.1 with Bing"; this is identical to the regular version of the OS, but vendors who use it have to agree not to change the default search engine from Bing. End users who buy one, however, are free to change this to Google, Yahoo or anything else.

On paper, this is a basic but reasonably well-specced machine, packing a dual-core 2.16GHz Celeron N2840

processor, with 2GB of RAM, an 11.6-inch display at 1,366 x 768-pixels, two USB ports (one 3.0), HDMI output, webcam and even 802.11ac Wi-Fi and Bluetooth 4.0. The APC team was divided on the exterior: there's a rough, matte feel to both the chassis and keyboard, which some people liked the ruggedness of, while others thought it felt dirty and 'unfinished'. It's at least light weight, though, at 1.27kg sans power-brick.

While nothing here is from the top shelf, those components do get the job done – but not much more. The screen is a good example. Sit right in front of it and it's fine for web surfing and watching the occasional YouTube vid. However, its viewing angles are extremely narrow, and peer closely and you'll notice there're vertical gaps in the pixel array leading to a pin-striping effect. We suspect the trackpad is resistive too, rather than the more-expensive capacitive type, as it has a

habit of not working unless you're pressing down gently.

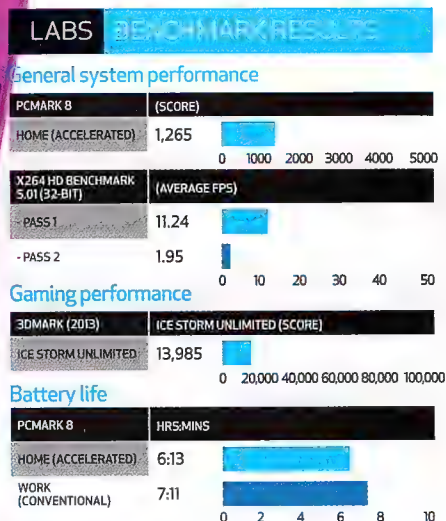
Still, that processor's good enough to handle a bit of light multitasking, but don't ask it to do anything serious like media encoding – our x264 benchmark basically brought the whole system to a standstill for the 4 hours it took to complete. On the plus side, those low-end specs mean its battery life can stretch to up to 7 hours.

In fact, the only really serious caveat here is drive space, with only 32GB of flash-based eMMC storage on board. To its credit, HP has somehow managed to squeeze the full Windows 8.1 install down to just 7GB, but with a 7GB recovery partition on top of that, on the Stream 11 you're left with a rather paltry 15GB of usable space for your own apps, games and files. An SD card reader on the side can potentially give you a little more space – and when inserted, cards go most of the way in, with just a couple of millimetres poking out – but that's far from ideal.

What does help increase the value (and overall appeal) is that there's a one-year subscription to Office 365 thrown in too, so you get the full versions of Word, Excel, Outlook and OneNote – something that'd otherwise cost \$89, if bought directly from Microsoft's online store.

With the colour scheme, HP is obviously pitching this and the slightly-larger Stream 13 (a 13.3-inch unit which sells for around \$400) as great laptops for kids, and with their affordable pricing and gets-the-job-done specs, they do a pretty good job of being just that.

■ Dan Gardiner



Verdict

Features
Performance
Value



An appealingly-affordable Windows alternative to Google's Chromebooks, and a great starter PC for young kids.





TABLET

FROM \$479 | PLAY.GOOGLE.COM/DEVICES

Google Nexus 9

Google abandons its usual low pricing to enter the high-end tablet market. We wonder if any Apple users will jump ship to the Android fleet?

Google's Nexus 9 has been designed by HTC to be the Goldilocks of pure Android tablets and, for the most part, it succeeds at being 'just right' next to anything but an iPad. It's not as big as the seriously outdated Samsung-made Nexus 10 and not as small as the ASUS-crafted Nexus 7. It's the silver bullet of tablets, but it will cost more of your hard-earned gold.

Its Android competition includes the Samsung Galaxy Tab S, which flanks Google's 8.9-inch option with 10.5- and 8.4-inch sizes, and the Sony Z3 Tablet Compact. But more than hardware, what the Nexus 9 has going for it is the fact that it's so far the only way to dive into Android 5.0 Lollipop on a tablet. That makes it a sweet enough product, in more ways than one. The new unified look, 'Material Design', is bright and colourful within the operating system as well as Google's own apps.

Considering it comes from the company that brought us the polished-looking HTC One M8, it's no surprise that it includes a brushed metal rim, but it sticks with a soft, rubberised back cover – the same as on the smaller Nexus 7.

The Nexus 9's 8.9-inch display is a little smaller than the 9.7-inch iPad Air 2, but offers the same maximum resolution on its IPS LCD screen.

The physical buttons on the rim are not always easy to find – if you've used the Nexus 6, you'd appreciate a power button accented with ridges. Thankfully, it's not always imperative to find that itty-bitty power button when the tablet is lying flat on a desk: a new 'double-tap to wake' feature in Android 5.0 Lollipop conveniently wakes the Nexus 9.

The lack of a micro SD card slot is the biggest design omission. There's no expandable storage, meaning the 16GB model is going to be a tough sell if you

use even a little bit of non-streaming multimedia.

The Nvidia K1 Tegra processor is a switch from the typical Qualcomm Snapdragon chipset we're used to finding behind Android tablet displays, but the good news is that it's still a 64-bit system on a chip. The new Android Lollipop takes advantage of such 64-bit architecture, which makes the Nexus 9 a fair bet for the future. The processor and Lollipop together should result in more powerful apps.

The Tegra K1 processor's single-core Geekbench 3 score actually surpassed that of the new iPad, averaging 1,939, while one core of the iPad's processor averaged a score of 1,815 in similar tests – although, of course, the Tegra K1 is a dual-core processor, as compared with the iPad's three-core.

At full brightness, our battery tests found that a 90-minute Full HD video took the battery life down to

82% – that's a drop-off that the iPad Air 2 just didn't match. In other real-world testing, the Nexus 9 lasted a day and a half before recharge. Battery life is less of an issue on a tablet than a smartphone, but the Nexus 9 is no slouch.

If you're looking for a naked Android tablet, the Nexus 9 performs well and comes with some really premium touches to make it one of the best around. However, it's not the winner at this point, so it will be interesting to see how Google uses this base model to improve on over time.

■ Matt Swider

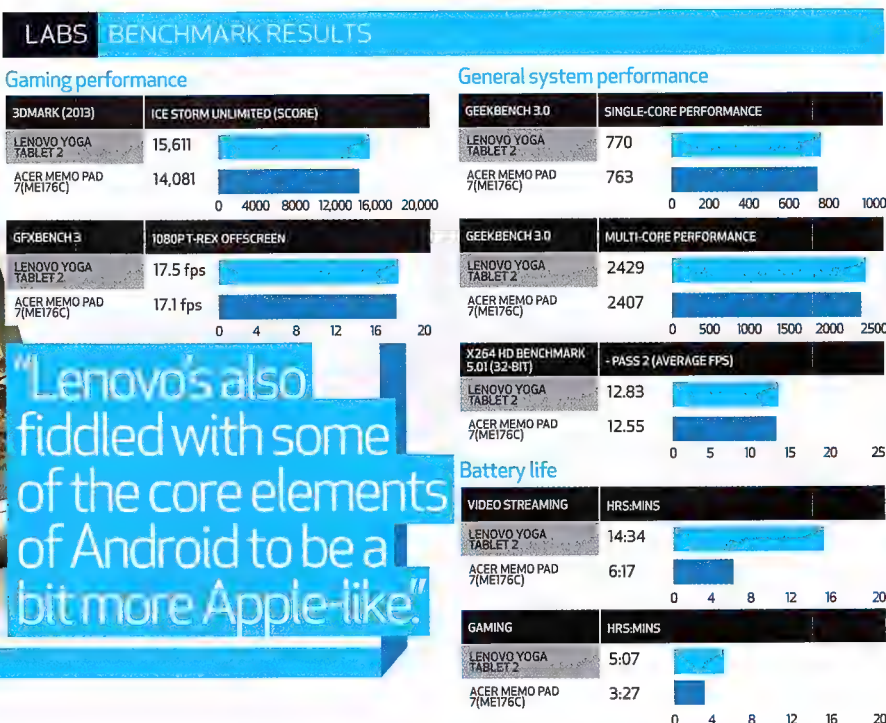
Verdict

Features
Performance
Value



An upgrade to last year's Nexus 7 and a great debut for Lollipop, but it doesn't measure up to the iPad Air 2.





Lenovo Yoga Tablet 2

Lenovo’s uniquely-designed (but very divisive) Android tab gets an update.

Even amongst today’s sea of low-priced tablets, to get a big, name-brand unit for just \$399 still sounds like an attractive deal. This Android-powered 10.1-inch unit from Lenovo promises just that, and on paper it offers some pretty decent specs, including a headlining claim of 18-hour battery life, plus a built-in stand and a screen that’s Full HD resolution at 1,920 x 1,200-pixels.

Like many of the Android tablets we’ve seen from major vendors this year, Lenovo’s opted for an Intel-based framework for the underlying hardware. There’s a quad-core 1.86GHz Atom Z3745 processor running Android 4.4.2, plus 2GB of RAM and 16GB of onboard storage – enough to keep things running adequately for most tasks, including a bit of gaming.

Of course, the first thing to stand out with this tablet is, like on its predecessor, that bulky cylinder along the long bottom edge.

Whether you think this is a good or terrible idea is likely to come down to personal taste, but it’s hard to deny that Lenovo’s put that extra space in the hinge to good use, using it to increase the battery up to a whopping 9,600mAh (where most 10-inch Android tablets range around the 6,000mAh mark) as well as throwing in left and right stereo speakers for better (though admittedly still not great) acoustics, as well as incorporating a fold-out stand. That cylinder gives you something to hold onto when using the Yoga 2 in portrait mode, and the fold out stand has two very sturdy positions – 45° and 90° – so you can stand it straight up and watch videos, or flip it over and have a nice angle for typing, as required. And it does improve battery life – our test unit lasted over 14 hours in video playback, a good 4 hours above average. The downside, of course, is that the cylinder adds a lot of bulk and weight and it

means the tablet doesn’t slip into a bag as easily.

Some other components could be better, too. While the screen is certainly high res and quite bright, it isn’t the best in terms of colour or clarity. Compare this Yoga to an iPad, Samsung or Sony tablet and its colours look muted and a bit washed out. Its response time also seems a bit slow – we saw noticeable ghosting at some points in the GFXBench T-Rex test, with fast-moving images persisting on screen and creating trails.

Lenovo’s also fiddled with some of the core elements of Android to be a bit more Apple-like. Instead of having buttons in the notification bar (ie. up the top) to turn certain hardware features on and off – like Wi-Fi, Bluetooth, switching screen rotation on and off, or adjusting the brightness – Lenovo’s created a control centre that you access by swiping up from the bottom of the screen, ah-lah iOS 7 and 8. It works well enough, but if

you’re used to the Android defaults it can take a little bit of brain power to remember it’s there.

Ultimately, Lenovo’s not the only big brand to offer 10-inch tablets at this price and how you feel about the Yoga Tablet 2 will probably largely come down to that big cylindrical hinge. For us, despite the advantages it provides, it proves a little unwieldy in day-to-day use and the extra weight reduces portability. If you have \$400 to spend on a tablet, our recommendation is still to try to stretch to the \$499 asking price of Apple’s original iPad Air.

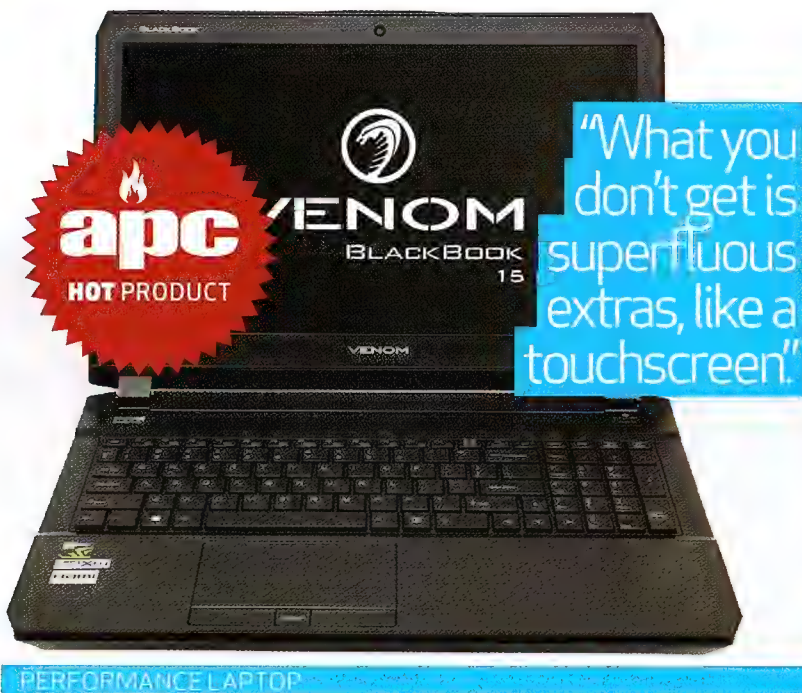
■ Dan Gardiner

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

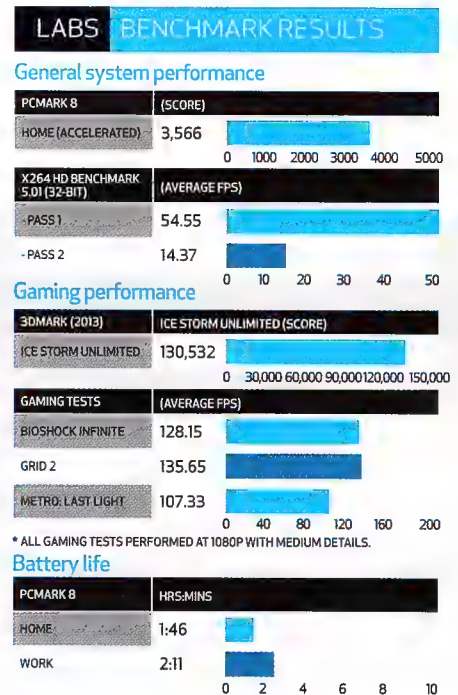
A fast-enough tablet for the price, but overall appeal will come down to how you feel about that cylindrical hinge.





PERFORMANCE LAPTOP

\$3,399 | VENOMCOMPUTERS.COM.AU



Venom BlackBook 15 (2014)

A blistering-fast performance laptop from an Aussie PC company.

From the outset, Venom's new 15.6-inch BlackBook has one clear advantage over its 2013 predecessor: it's a lot more physically attractive, with a slimmer build (43mm to 29mm) and lighter weight (3.1kg down to 2.6kg) making it at least a little bit more portable. Although that said, this is still undeniably a large laptop – it's not something you'll want to be carting in a shoulder-bag to far-flung daily meetings. This is a powerful laptop that's designed to live on a desk.

To that end it's full of high-end components and it's even managed a couple of firsts too, being the first laptop through APC Labs to pack a 3K (aka 2,880 x 1,620-pixel) IPS display and also run Nvidia's brand-new GeForce GTX 970M GPU.

The rest of the core components are top drawer too: a Core i7-4710HQ processor, an unreasonably fast 256GB Samsung XP941 M.2 solid-state drive (see

page 47), 16GB of low-latency DDR3-1866 memory and a 7200rpm 1TB hard drive for general storage. That's rounded out by three USB 3.0 ports, dual DisplayPorts and an Intel Wireless-AC 7265 Wi-Fi chip.

What you don't get is superfluous extras, like a touchscreen.

All that, as you'd expect, leads to a laptop that absolutely flies in both day-to-day use and demanding tasks. This is the speediest portable we've tested when it comes to gaming, media encoding and image rendering – and it does all that without really breaking a sweat, with the GPU never topping 70°C. By way of comparison, other laptop GPUs routinely hit 80°C when pushed.

That said, all that power comes at a price – or two prices really. First, the power brick is a big beast, weighing nearly a kilo, and second, the battery life isn't great, only lasting between 1:46hr to 2:11hr in PCMark 8's (admittedly-

demanding) battery tests. There are some nice little touches though.

Rather than chewing up precious drive space with a recovery partition, there's a dedicated USB stick for re-imaging the machine. Also neat is that Venom has customised Windows' image scaling settings (which control font and icon size) to work better with the 3K screen res. And lastly, there's a 1-year subscription to Norton Internet Security pre-installed – more generous than the usual 90-day trial on most laptops.

The main downside is price. We tested the midrange build, which will set you back a not-inconsequential \$3,399. That puts it in the upper ranges for a laptop (even with these specs), and it'd be remiss of us not to point out that Metabox – another Australian laptop retailer – offers machines based on the same template as this BlackBook at lower prices. (Although not, perhaps, with quite as premium

components – there's no M.2 SSD, for example, just a SATA 6Gbps one.)

Venom's previously told us that its policy is to use premium parts wherever it can because it wants to avoid returns and repairs – which, after all, cost the business time and money. But better components ultimately means a steeper upfront price. Still, it's hard to deny the charms of the BlackBook 15 as a high-quality, high-performance laptop. If you're willing to pay that top-shelf price, you'll find few better performance laptops than this one.

■ Dan Gardiner

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

Offers top-drawer features and performance which, of course, demands a top-drawer price.



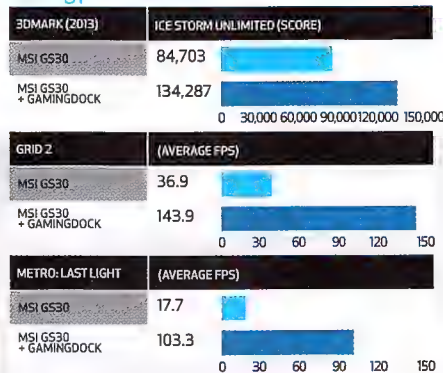


LAPTOP & DOCK

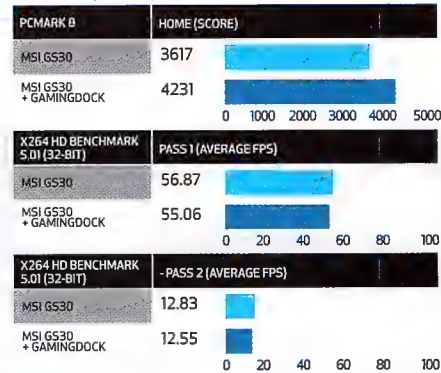
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LABS BENCHMARK RESULTS

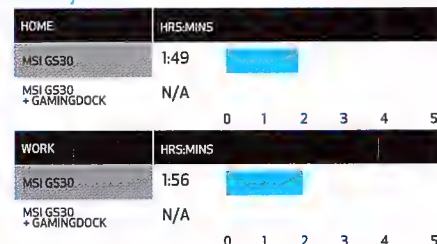
Gaming performance



General system performance



Battery life



MSI GS30

The ultimate convergence of desktop gaming and laptop portability?

Let's face it: for many of us, our basic day-to-day computing needs can easily be accommodated by a laptop. Surfing the web, email, writing and watching movies are all things that don't really require the power of a desktop PC. It's only high-end tasks like gaming or media creation that demand a desktop.

MSI's hoping to cash in on that idea with its latest bit of kit, a weird but perhaps not-entirely-crazy concept: the GS30 bundles a high-spec 13.3-inch laptop along with a hefty box that MSI's calling a 'GamingDock'; basically, it's an enclosure consisting of a desktop PC power supply that'll let you install your choice of Nvidia or AMD desktop graphics card. Oh, and if desired, you can throw in a second hard drive too, and rounding the dock out is a four-port USB 3.0 hub and Gigabit Ethernet port — allowing you to have a mouse, keyboard and wired networking permanently plugged in.

In theory then, this two-part kit gets you the best of both worlds: a laptop that's slim and light enough to go anywhere, but which can transform into a powerful gaming PC when you get home.

Even sans dock though, the GS30 laptop is incredibly well-specced, packing Intel's top-drawer mobile Core i7 CPU (the 4870HQ, which operates between 2.5-3.7GHz) and fastest integrated graphics chip (the Iris Pro 5200) alongside a 1080p IPS display, storage that's handled by a pair of 128GB SSDs in RAID 0 (a set up that blitzes benchmarks with transfer speeds up to 1,000MB/s) plus 802.11ac Wi-Fi and a big trackpad and chiclet keyboard that's comfortable to type on.

The GamingDock is pretty simple, with the graphics card's ports accessible on the left side and the USB and networking on the right. Docking the GS30 requires placing it on a tray, which then slides backwards to mate the dock connector

with the slot on the laptop's back edge.

Once inserted, the GS30 is locked tightly in place. It's a two-step process to remove it, involving sliding a plastic tab and then pulling a lever to 'eject' the tray. You can only dock or undock with the laptop off; try and remove it while on and you'll get a loud and continuous warning beep — proceed anyway and the laptop'll immediately reboot.

When docked, gaming performance is obviously going to be contingent on the graphics card you install. MSI shipped our test unit with a GeForce GTX 980 pre-loaded which, as you'd expect, gave pretty stellar results that were often spot on what we'd seen when using a Core i7-4970K and Z97 motherboard desktop rig. We did find *Metro: Last Light* — a game that's more CPU intensive — was bottlenecking at higher settings, but even so, performance was only about 10% behind the desktop.

As a standalone laptop,

though, the GS30 isn't as crash hot. It's fast, but you can't stuff a small notebook full of high-end kit without consequences — and those come in the form of heat, noise and poor battery life. Try and game using just the laptop and, apart from obviously much-lower frame rates, the GS30 gets very hot very quick. And to dissipate that heat, it's got a very loud cooling system, with fans that emit a high-pitched whooshing sound.

Battery life, at just 2 hours doing office tasks, also means that despite its compact size, it's not great for taking on the road.

■ Dan Gardiner

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

Its gaming chops are hard to deny, but the balance between power, portability and battery life is a bit off.





SYSTEM

FROM \$619 | WWW.APPLE.COM/AU

Apple Mac mini (Late 2014)

Apple's new baby Mac gets an upgrade – and a downgrade.

Apple giveth, and Apple taketh away. After a couple of years of neglect, the lovely little Mac mini has been updated, bringing substantially faster graphics, faster Wi-Fi, more and faster Thunderbolt connections and a cheaper entry point, but at the same time we've lost the ability to upgrade the RAM ourselves, lost the option for a quad-core configuration, and lost the server variant that had two 1TB hard disks inside the chassis. There's also no optical drive, unsurprisingly, and now no FireWire ports, though if you need to use FireWire peripherals you can buy an adapter – Apple's is \$35 – to convert one or both of the Thunderbolt ports.

Here we're reviewing the top-end model – 2.8GHz i5, 8GB RAM and a 1TB Fusion Drive, Apple's hybrid disk

technology that pairs (in this case) a PCIe-connected fast SSD with a hard disk, to get the speed benefits of SSD without its high price. It scores fairly well in raw number-crunching benchmarks such as Geekbench, but note that because it has only two cores (for four threads) rather than the four cores (eight threads) of the previous top-end model, the multi-core result is much lower. It's hard to be definitive about whether this is a step forward or backward; if you frequently push your Mac to do many complex things at once and/or use multi-core aware apps, the previous high-end Mac mini might actually have been computationally more capable, but this new one, to put it crudely, is 'faster at doing fewer things'.

The Intel Iris Graphics chipset is irrefutably much

more capable, but even here don't run away with the idea this is a Mac with much in the way of gaming chops. We got 18fps (frames per second) in our standard *Batman Arkham City* benchmark, and 7.6fps in the new *Tomb Raider*. To be sure, you can turn the settings down in both until you get a usable result, but while the Iris (not Iris Pro) graphics we have here are plenty capable of powering the Mac's UI, unless your gaming needs are very modest, this is not the Mac for you.

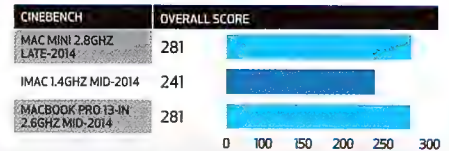
Don't buy a Mac mini because it's 'cheap'; by the time you add a screen to this one, it might not be much cheaper than an iMac. You might be more productive with a slower MacBook Air for about the same price just because it's more flexible, or get so much more from a more powerful iMac that it negates the price difference.

What's more, you now need to be sure that a Mac mini is configured right before you buy it, since you can no longer even upgrade the RAM. Happily, 8GB is enough for general computing, especially when paired with an SSD, but consider the 3.0GHz i7 upgrade if you do heavy creative tasks, or the 512GB pure-SSD upgrade for better responsiveness.

■ Christopher Phin

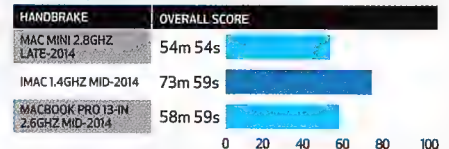
LABS BENCHMARK RESULTS

General system performance



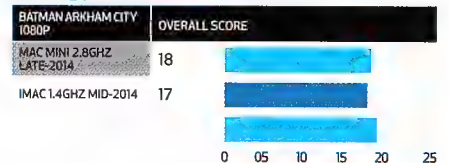
Cinebench renders a photorealistic scene using various algorithms across every processor core available. Fast processors with more cores will score higher.

Encoding performance



We transcode a Blu-ray video file into H.264, using Handbrake. This gives us a real-world test of processor capability, pushing all four processor cores to the maximum output.

Gaming performance



For a real-world gaming test, we use the benchmarking tool in the game *Batman Arkham City*, with the graphics settings set to High and the resolution set to 1080p.

Verdict



Apple has rededicated the Mac mini to the role of modest but capable. Good — for the right people.

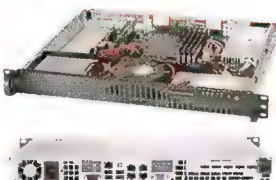


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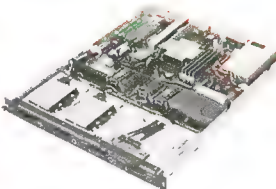
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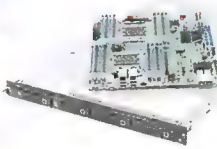
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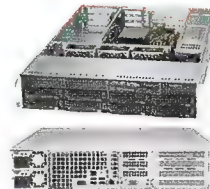
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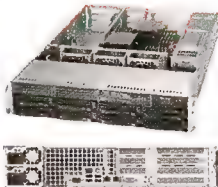
- Intel Xeon E5-2600/1600
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- IPMI 2.0 with KVM over LAN



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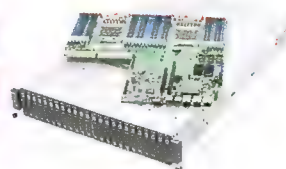
- Intel Xeon E5-2600v2
- 8x HOT SWAP Drive Bays
- IPMI 2.0 with KVM over LAN



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Lenovo ThinkPad W540

A top-notch 3K workstation... that's built for Linux?

Linux users have limited if any choice when it comes to laptops and even less choice with high-end workstation models. Coming with Ubuntu certification, Lenovo's new ThinkPad W540 workstation is one of the few that meets the requirement. While Lenovo won't ship it with Ubuntu installed, it comes with full Ubuntu 12.04 certification.

Packing a 15.6-inch, 2,880 x 1,620 (3K) resolution IPS display, the W540 is a mobile visual studio built on Lenovo's platform of ThinkPad workstations. Add in a high-end 2.7GHz Intel Core i7-4800MQ processor with an Nvidia Quadro K2100M graphics card, and this machine is ready to tackle anything from simple word processing to 1,000 page spreadsheets and heavy 3D modeling.

However, at \$3,199, you've got to ask yourself if the power is worth the price. There isn't anything noteworthy about the W540's design. It's a carbon

copy of previous ThinkPad notebooks. It folds up into a plain, grey rectangle devoid of flashy accents, and featuring only a few curved edges.

What the W540 lacks in style, it makes up for with a carbon-fibre-reinforced plastic body wrapped around a magnesium rollcage. With these rugged elements combined, you can expect this laptop to survive falls and other accidents that would otherwise damage other notebooks.

With such impressive (and expensive) parts, the W540 performed flawlessly with any application we used. It never stuttered, regardless of whether we were browsing the web, editing images or looking at 3D printing models. One side note: games do not run well on the W540, but the problem is not due to a lack of power. Rather, it is because game developers often do not account for workstation-grade graphics cards, such as the Quadro line.

The best thing about the W540 is its gorgeous 3K

screen. At 2,880 x 1,620 the pixels on this 15.6-inch screen are virtually indistinguishable. What's more, it's bright and colour-accurate, and for those who need pro-standard colour fidelity can be calibrated with the optional X-Rite Integrated Color Calibrator. Post calibration, the colour became even more vibrant and true-to-life than on our benchmark MacBook Pro with Retina display.

Unfortunately, the high-resolution screen also eats into battery life. During our battery test the ThinkPad W540 lasted only three hours and seven minutes. With normal use you can expect to squeeze out four hours and nine minutes, split between more than a dozen tabs of web browsing, some image editing and streaming 4K video on YouTube, even running it with moderate use and a dimmed screen we got at best five hours and 17 minutes with modest use.

So is it worth buying? Aside from the solid build quality and usability we've

come to expect from Lenovo, the W540 also offers a uniquely gorgeous screen. It displays text and images with great contrast, gorgeous colours and amazing resolution. We've never seen a screen on a laptop to match it. Plus the W540 actually has components with enough power to drive this high-res 3K display. If you're in the graphic design or photography world, this is one laptop definitely worth considering. Only the expectedly limited battery life, disappointingly modest disk space (500GB HDD as standard or 256GB SSD) and high price tag count against it. ■ Kevin Lee

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

Superb screen, but pricey. There are lots of rivals to consider, some with even higher-res screens at lower cost.



Verdict

HP Z440 WORKSTATION

A powerful business-focused PC that does almost everything right and can be customised to your exact needs.



✓✓✓
apc
RECOMMENDS

Verdict

HP DREAMCOLOR Z24X

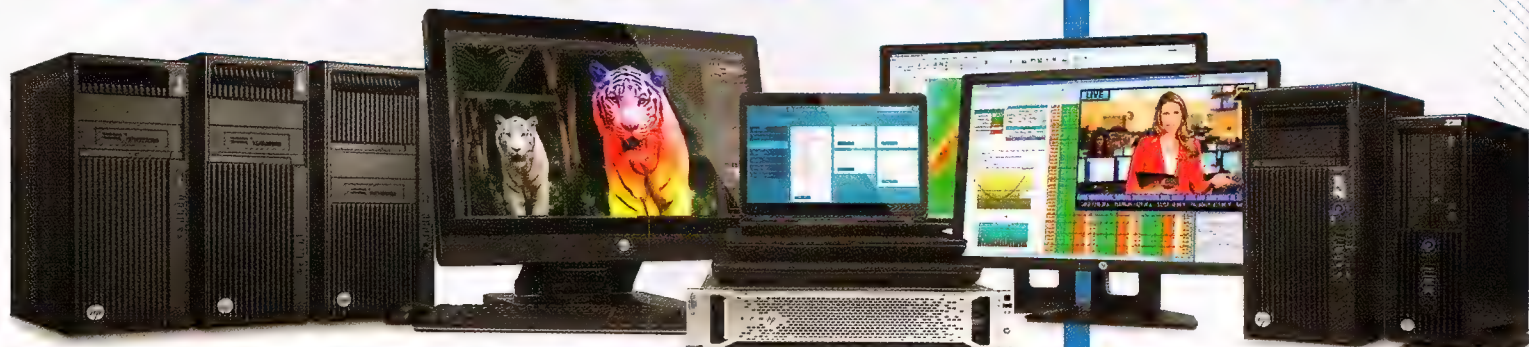
A stunning display that comes factory calibrated to ensure accurate colours on your creative projects.



Verdict

HP ZBOOK 17

A pricey but very well specced laptop for those who need to get creative while on the go.



DESKTOP & LAPTOP WORKSTATIONS • PROFESSIONAL MONITOR

HP Z440 WORKSTATION \$7,999, HP DREAMCOLOR Z24X \$999, HP ZBOOK 17 \$4,999 | WWW.HP.COM/AU

HP Z-series workstations

Pushing business productivity to new heights?

Built specifically for pros who need big performance, HP's new Z-series workstations come in a number of configs, from the extremely powerful Z840, the mid-range Z640 and the more affordable Z440. That said, even the base model is a high end machine.

We've tested a Z440 here, which features an Intel Xeon E5-1650 v3 CPU, 32GB of DDR4 RAM and an Nvidia Quadro K4200 GPU with 4GB of memory. It also has a 512GB HP Turbo Drive PCIe SSD, a secondary 1TB 7200rpm hard drive and a Blu-ray reader. You can totally customise your system, with a more powerful CPU and GPU, up to 128GB of RAM and masses of storage. The HP Z440 handled our productivity benchmarks with aplomb and the PCIe SSD gave impressive data access speeds. It has plenty of USB 3.0 ports, but the audio is a bit of a letdown – just a basic integrated Realtek ALC221 chipset with a 3.5mm audio jack.

While performance is paramount, HP's workstation line-up is also claimed to have better reliability, with carefully tested parts backed by a three year warranty.

For best effect you'll obviously need to couple your workstation with a professional display – and (no surprises) HP suggests its own DreamColor units. We tested a 24-inch unit with the Z400, which uses an AH-IPS panel and has a 1,920 x 1,200-pixel resolution (and 16:10 aspect ratio) and a 6ms GTG response time. The screen supports 10-bit colour and will display 100% of sRGB and 99% of the AdobeRGB spectrum. Not surprisingly, it looks gorgeous, with crisp punchy colours and no sign of light bleed. It will also handle 4K inputs, has HDMI, DVI and DisplayPort connections and is also available in 27-inch.

A desktop workstation might be a powerhouse, but sometimes you need portability too. Squeezing the business-focused tech of its desktop cousins into a

mobile form factor, the HP ZBook line-up comes in 14, 15 and 17-inch varieties. We tested the latter, with a high end Intel Core i7-4810 CPU, 16GB of DDR3 RAM and a 256GB SSD – all of which are upgradable. The 17.3-inch display is driven by an Nvidia Quadro K3100M GPU and has a full HD 1,920 x 1,080-pixel resolution. The IPS DreamColor panel is one

legacy VGA – no HDMI in sight. You do however get ExpressCard and SD card slots as well as a Gigabit LAN port.

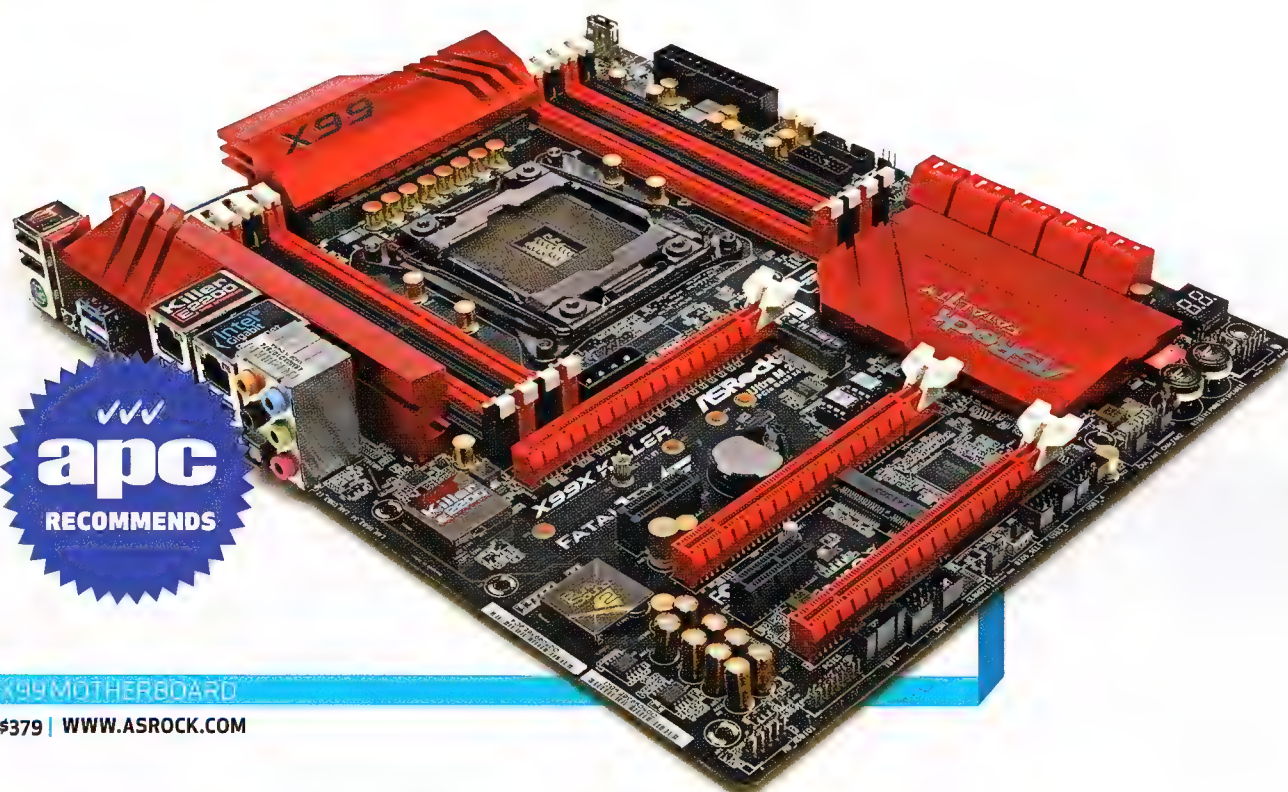
It normally wouldn't be fair to compare a desktop to a mobile workstation, but HP has made a real effort to close the gap. The desktop of course is faster (and can be easily specced to be even further ahead) but,

"For best effect you'll obviously need to couple your workstation with a professional display."

of the best-looking laptop screens we've ever used and will ensure accurate colours from desktop to mobile. The ZBook weighs 3.48kg and has three USB 3.0 ports and one USB 2.0, plus Thunderbolt and 802.11ac Wi-Fi. Like the desktop, we would have liked to have seen better audio support – you only get a single 3.5mm headphone jack. Video outputs are also a little thin, with DisplayPort and

somewhat surprisingly, the ZBook can hold its own in most cases. Graphical performance is significantly lower due to the mobile GPU, but it still has enough grunt to let you do demanding multimedia work on the go.

The HP Z series desktop and laptop may be pricey, but for a totally customisable high performance PC tailored to business and creative use, they are solid offerings. ■ **Lindsay Handmer**



X99 MOTHERBOARD

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ASRock Fatal1ty X99X Killer

A solid board with impressive performance.

There really isn't much to separate this top-end ASRock X99 motherboard from its smaller X99M Extreme4 sibling. There are some obvious differences in scale and memory support, but in the rest of the spec – and particularly performance – these two mobos are like peas in a PCB pod.

There's a pretty good reason for that – they're both from essentially the same family. True, this ATX version is from the higher-end Fatal1ty Killer series, with gleaming metallic red heatsinks following the Wendel-based branding, but if you peel the name sticker off the X99M you'll find it's a Fatal1ty PCB too. ASRock has used the same actual board for both the micro ATX Extreme4 and Fatal1ty X99 mobos, then swapped the red heatsinks for blue and added a Killer networking chip. It works the other way around

too – underneath the X99X Killer sticker, the Extreme4 branding is on the PCB.

That all speaks well to the build of ASRock's boards, because this full-scale Fatal1ty version is a real powerhouse. The premium components used in its makeup make the X99X one of the quickest overall X99 boards we've tested, only slipping behind the excellent ASUS X99 Deluxe in stock performance benchmarks. It also has the same speedy storage as its smaller sibling, allowing for the same quick sequential read/write speeds from the PCIe M.2 connection.

The weighty power design used in both ATX and mATX form factors means the overclocking performance of the Fatal1ty board is almost identical to that of the X99M Extreme4. We hit 4.4GHz easily, partly thanks to the quality of the board itself and also to the impressive new ASRock BIOS screens.

The company has obviously been putting the work in on that front, making tweaking your machine a doddle. Like MSI's X99 boards, the ASRock BIOS has a neat Multicore Enhancement option that lets you bypass the 3.3GHz limit Intel has in place to stop the 5960X hitting its 3.5GHz Turbo speed when all cores are in use. Switch it on and you'll run up to 3.5GHz without any trouble at all.

On the downside, both these ASRock boards hit a wall when trying to run our high-end Corsair RAM under the XMP setting. We did get a little further with this larger board though – there's an option to overclock to 4GHz in association with XMP, which allowed us to boot. Once. The memory was running at 1.35v rather than 1.2v and the whole machine crashed in the second runthrough of the Cinebench rendering test.

This isn't such a problem

for the cheaper X99M, but this \$350+ option really ought to be capable of running at the 3,000MHz overclocked memory setting on the box. This is the whole reason XMP was created – so we don't have to mess around with timings and voltages to get our RAM to run. And when ASUS's OC Socket is capable of running the top memory settings without breaking a sweat, for the same price, the latter's X99-A suddenly becomes a far more attractive board.

■ Dave James

Verdict

Features
Performance
Value



A solid, weighty motherboard, with impressive performance only let down by its disappointing memory support.



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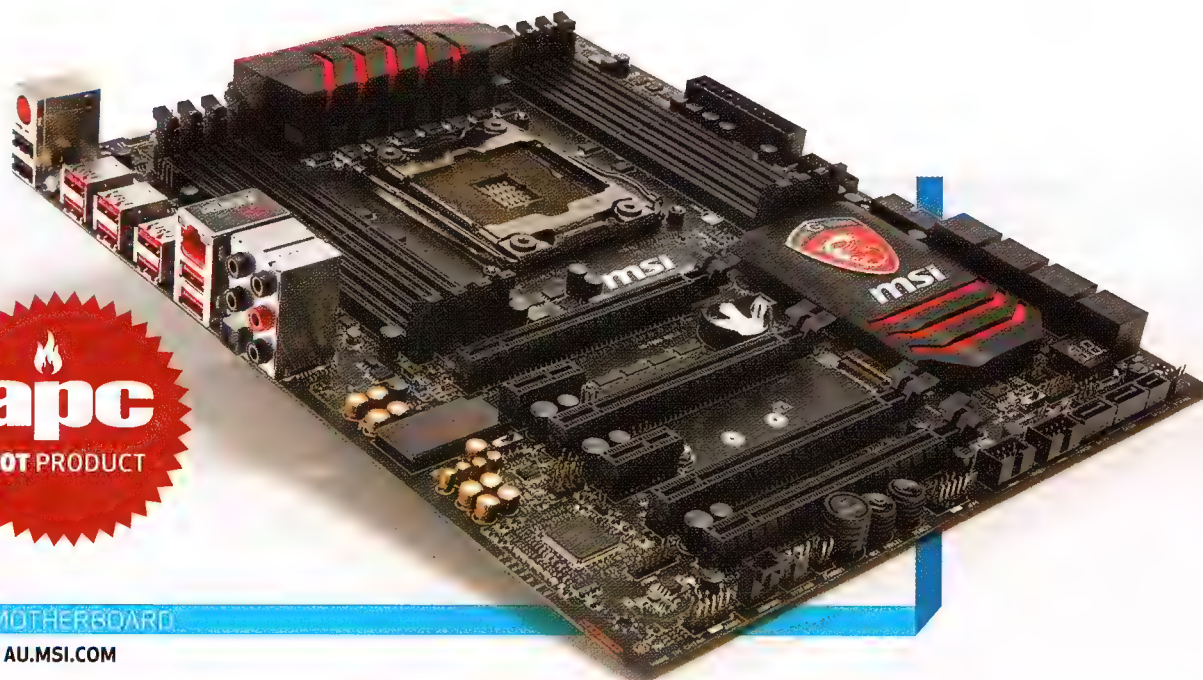


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MSI X99S Gaming 7

A more reasonable board for a more civilised CPU.

You don't have to spend \$600 on an X99 motherboard to ensure you get access to the full workings of your Haswell-E CPU, but you will have to spend more on your mobo than with the standard Haswell range. You will be able to pick up \$300-odd boards at the low-end of X99 ranges by MSI and Gigabyte, and they'll probably give a pretty good account of themselves, but you're likely to be losing a chunk of functionality and expansion options.

So this \$350-ish price point could end up being the sweet spot for the X99 range – especially for those Haswell-E purchasers not going for the super high-end Core i7 5960X.

Although, if you've dropped \$1,200 on a processor you're more concerned about functionality than price and so you're more likely to be happy spending \$600 on the sort of feature-set the X99 Deluxe is packing.

But one of the really interesting parts of the new Intel range is the bottom rung of the Haswell-E ladder: the Core i7 5820K. That's the cheapest of the new high-end, server-based chips and also the cheapest six-core CPU we've ever seen from Intel. It's only a little more expensive than the quad-core Devil's Canyon i7. Pair it with a powerful little motherboard like this one, and you'll have an incredibly potent machine with processing power you'd have paid twice as much for just a few months ago.

You'll get the performance you want out of the Haswell-E CPU with this sub-\$400 motherboard, and a better feature set than you'll find in the lowest end of the X99 range. That's especially important if you're looking at the overclocking performance of the six-core CPU SKUs. We haven't had a chance to check out how well the i7 5820K overclocks, but MSI's X99 Gaming 7 is only 50MHz

shy of the top clock we managed on our engineering sample i7 5960X. That bodes well for how it will perform with the cheaper chip, and makes us excited about the powerful machines we'll be able to put together with this new range, without breaking the bank.

In terms of what you're losing with the cheaper MSI, it's all about connectivity. There are fewer active SATA ports with the MSI, and one less SATA Express connection. Higher-end boards like ASUS's X99-Deluxe do include extra features beyond what the Gaming 7 has – in that ASUS case, that means you get an add-in M.2 x4 board and things like more USB 3.0 ports, 7.1 audio, dual LAN ports and Wi-Fi capabilities too. But arguably those are luxury features, with no bearing on the straight-line performance of the two boards.

That's not to say this MSI board is feature-poor, though. It's got pretty much all you could ask of a base

for your system – it's just that higher-end boards do offer more. The X99S Gaming 7 lines up as a solid alternative motherboard – it's just a little lighter on connectivity but gives the same great Haswell-E performance. If you're going for one of the budget chips, then MSI's Gaming 7 makes for a capable home for it.

■ Dave James

Verdict

Features
Performance
Value



Doesn't have quite the feature set as some, but offers the same performance for a lot less cash. A tempting option.





NAS BOX

\$3,499 | WWW.NETGEAR.COM.AU/

Netgear ReadyNAS 716

Don your crash helmet as we test out the 10GbE beast from Netgear billed as the fastest NAS in the world.

Billed by Netgear as the world's fastest desktop NAS, the six-bay ReadyNAS 716 is deserving of this accolade by virtue of a quad-core Intel Ivy Bridge Xeon E3 processor and 16GB of RAM. But that's far from all: in addition to a pair of Gigabit ports, you also get two 10GbE interfaces as standard. All of which puts the latest ReadyNAS on a par with a mid-range server in terms of specification.

Carriers to take 3.5-inch or smaller 2.5-inch SATA disks are included, and these simply slide into a vertical stack of six slots behind the front door. A small catch on each carrier prevents accidental removal but there are no physical locks, either on the carriers or the door.

Default shares are created during setup but more of the same and iSCSI volumes can both be configured when it comes to user authentication and access. The latest implementation of the ReadyOS firmware also sees

a switch from EXT4 to the BTRFS file system, which among other features adds support for block level snapshots. Moreover, an unlimited number of snapshots can be taken of both iSCSI volumes and network shares, with simple tools to manage the process and roll back to an earlier snapshot using a timeline.

For our tests we borrowed an eight-port Netgear ProSafe XS708E. Indeed, using a Fujitsu server to exercise the storage on the ReadyNAS we hit an impressive 420MB/s when writing large files over a 10GbE connection and up to 480MB/s for reads. When copying smaller files, however, the figures were reduced, and similarly, replacing the SSDs with magnetic disks slowed things down.

Some buyers will be limited to Gigabit networking, and using its Gigabit ports the ReadyNAS 716 took full advantage of the available bandwidth. In

practice we would expect such buyers to make use of all four ports either through the various trunking options or by VLAN segmentation and, perhaps, upgrade to 10GbE later.

The web management interface is where you'll spend most of your management time, and we found this dated but nice to use and easy to learn.

A good number of monitoring tools are also available, but performance is what the ReadyNAS 716 is all about, and in that respect the Netgear desktop appliance is hard to beat except by switching to rack-mount alternatives.

Of course there will be lots of companies without rack facilities who will find the ReadyNAS box easier to accommodate. However, the lack of a lock on the storage seems a bit of an oversight in this context and the appliance itself is a little on the bulky side. Also, at this price point we would like to see a redundant power

option whether for desktop or rack deployment.

Performance is the biggest selling point with the ReadyNAS 716, especially the 10GbE interfaces which come as standard – a first for a desktop NAS. It also has a lot to offer in terms of capacity with the option of expansion well beyond the basic 24TB of the standalone box, plus enterprise-class snapshot and backup capabilities. The only question is the price, which puts it up against mid-range servers and rack-mount storage appliances where the advantages are not so clear-cut. ■ Alan Stevens

Verdict

Features
Performance
Value



The world's fastest desktop NAS, but in a price bracket with rack-mount servers and storage appliances.





EXTERNAL HARD DRIVE

\$1,499 | WWW.LACIE.COM

Lacie Little Big Disk Thunderbolt 2

Blisteringly fast external drive with an eye-watering price.

Mention the Thunderbolt interface to anyone and their first remark will probably be: "Isn't that just for Macs?" And while it's true that fruit-logo'd products have had Thunderbolt interfaces for some time, the interface also works with Windows-based platforms, as can be seen by the number – albeit small – of Windows notebooks that support Thunderbolt.

The latest Thunderbolt 2 (it's sooo tempting to type Thunderbird 2...) specification takes the original two 10Gbps bi-directional channels and combines them into a single bi-directional 20Gbps channel. But although the throughput of a single channel has been doubled, the actual bandwidth of data going through the connection remains unchanged. That does now

mean, however, that it's possible to display 4K video using Thunderbolt.

One of the latest to join LaCie's clan of drives is the flagship Little Big Disk Thunderbolt 2, which has a quite a marketing tag to live up to: 'The World's Fastest Portable Storage.' A quick look at the performance figures LaCie quotes for the drive shows that for once it might not be marketing flimflam. Not only is it 'The World's Fastest Portable Storage', but that price must be in for some sort of prize as well.

So what's going on inside the Little Big Disk Thunderbolt 2? What enables it to produce eye-wateringly quick read/write speeds, or even begin to try to justify that price? Well, inside the wee, smart-looking aluminium enclosure (40 x 140 x 85mm) lurks a pair of Samsung 512GB XP941 PCIe x4 Gen 2 SSDs controlled by an Intel

L5520 controller, set up as standard in a RAID 0 (Striped) array – although RAID 1 and JBOD arrays are supported as well.

Not only does the case act as a heat sink, there's also active cooling in the shape of a 40mm Sunon Super Silence fan – which lives up to its name, as we never heard it once even when really pushing the drive during testing.

Plugging in the drive saw sequential read/write scores in ATTO of 1,296MB/s and 975MB/s, both of which are down on the official figures, but are still unbelievably fast for an external drive. To give an idea of just how fast the drive is we took a previous 'World's Fastest External Storage' champion from a few years ago: Western Digital's My Book VelociRaptor Duo. That drive teams a pair of the fastest desktop 3.5in drives, WD's 10,000rpm Velociraptor, with the

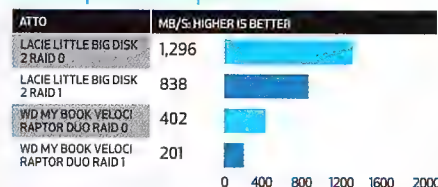
original Thunderbolt interface; we tested it in a RAID 0 array with ATTO, which gave Read/Write scores of 402MB/s and 365MB/s respectively.

But what about real life? We took our normal 60GB Steam folder and copied it to and from the drive. Comparing the Little Big Disk Thunderbolt 2 to the WD My Book VelociRaptor Duo showed hardly any difference between the two drives. That still makes it 'The World's Fastest', but doesn't justify that frankly insane price. ■ Simon Crisp

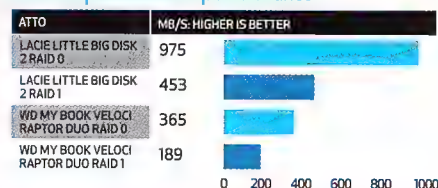
LABS BENCHMARK RESULTS

Using the drive in a laptop is as easy as plugging it in, but using it the way we did – with a plug-in card, a motherboard and Windows – is a bit more complicated. It needed a BIOS update and a few tweaks in the BIOS to get the drive running.

Peak sequential read performance



Peak sequential write performance



Real-world write performance



Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

Mighty expensive, but if you're after a pocket-sized drive with lightning speed then it's the only game in town.





NVIDIA
GEFORCE
GTX



SUPER
JETSTREAM 風

GEFORCE GTX 980

The revolutionary Palit JetStream 風 series of graphics cards features advanced innovative cooling and an optimized product design to deliver gamers the ultimate gaming experience. As the latest and the next generation NVIDIA Maxwell architecture features low power consumption, 4K Shadow Play and dynamic super resolution. With the GeForce Experience, the Palit GeForce GTX 980 JetStream guarantees gamers cutting-edge performance and an explosive new gaming experience.

6dB

EXTREMELY
QUIET

15%

OVERCLOCKING
PERFORMANCE

4.5°C

EXTREMELY
COOL

**0-20
TECH**

4K³

Keep Silent while you are experiencing the multimedia application and general workload. The operating fans only occurs while working on heavier loading such as gaming that the GPU temperature surpasses 60°C.

With its three DisplayPort ports, the Palit JetStream provides a flawless, jaw dropping experience at 4K monitors surround.

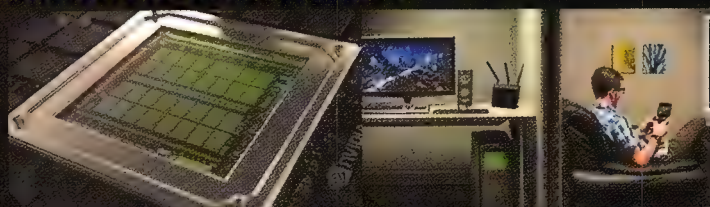


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BUY A NEW PALIT GEFORCE GTX 980 AND GTX 970 SERIES WITH GAME BUNDLE STICKER ON THE RETAIL BOX, CHOOSE YOUR FREE UBISOFT GAME.



NVIDIA GTX 900 SERIES FEATURES



NVIDIA Maxwell™

This is NVIDIA's most advanced architecture ever, delivering incredible performance and unmatched power efficiency. Plus, it offers cutting-edge features like advanced sampling and Dynamic Super Resolution (DSR) technology that delivers 4K-quality gaming—even on 1080p displays.

GeForce Experience™

The easiest way to optimize your games and keep your drivers up to date, the GeForce Experience application automatically notifies you of new driver releases from NVIDIA. With a single click, you'll be able to update the driver directly, without leaving your desktop. You can also capture and share 4K gameplay with NVIDIA ShadowPlay™.



Voxel Global Illumination (VXGI)

Part of the NVIDIA GameWorks™ library for developers, VXGI accelerates dynamic lighting effects for a truly immersive, cinematic experience. 1080p displays.

Dynamic Super Resolution (DSR)

This innovative feature can deliver 4K fidelity to 1080p displays for exceptional detail and image quality.



GAMING MOUSE

\$65 | RAZERZONE.COM



MECHANICAL KEYBOARD

\$190 | LOGITECH.COM/AU

Razer DeathAdder Chroma

Razer's flagship, now with colours.

Unlike the Razer Chroma keyboard we reviewed last month, which basically just added multicoloured lights to an existing design, the company's new DeathAdder mouse adds lights and some design tweaks and upgrades, meaning it's not just about being fashionable. It's kept the core aspects that have made it popular: this is a light weight, comfortable good-performing mouse — there's no wireless, nor extraneous buttons, adjustable weights or on-the-fly DPI switching.

This new design is, as before, asymmetrical and (currently at least) available in a right-handed model only. Physically, it's been slightly tweaked, with rubber pads on the sides of the mouse where your thumb and ring/pinky fingers rest, plus under the hood the optical sensor has been upgraded to a ridiculous 10,000 dpi.

Why ridiculous? That's

much more than is really practical. Even if you turn down in-game sensitivity to as low as it'll go, switching up to 10,000 dpi gives you a super-twitchy speed that's, frankly, going to be too sensitive for most. While individual comfort does vary on sensitivity, in testing, we never felt the need to go above 4,500 dpi.

At any rate, the extra dpi isn't detrimental to the performance: this is a very smooth and precise pointer with that organic feel that only optical can provide. The DeathAdder body shape is still as comfortable as ever too — it's easy to see why Razer hasn't changed it since this model's debut back in 2006. ■ Dan Gardiner

Verdict

Tweaks the DeathAdder design to good effect. A great performing mouse that's also nicely priced.



Logitech G910

A mechanical keyboard with some seriously funky keys.

Logitech's excellent G710+ won the top gong in our mechanical gaming keyboard round-up about 6 months ago (see APC July 2014, p56), so we were rather eager to test this new higher-end model, which promises a host of new features over its predecessor. Like most premium mechanical keyboards released of late, that includes customisable LEDs under each key, so you can deck out your board to look like you've spilled a pack of Smarties on it. Ahem.

Perhaps more useful are the new Romer-G switches underneath each key, which Logitech claims makes this the world's-fastest gaming keyboard thanks to "25% faster actuation", meaning, basically, that the keys fire higher-up — or don't need to be depressed as deeply. Physically, the Romer-G's feel close to Cherry's blue switches — there's a moderate bit of resistance, but no noticeable hump as

on Cherry browns. We had no complaints when it came to performance, although honestly that claim of being 25% faster is tough to actually feel.

What you can feel, though is the weird, angular key shape that Logitech has chosen. This seems more for style than comfort: rather than the gentle concave offered on most boards' keys, here there's a sort of a hard asymmetrical 'H' shape. While it's something you do get used to, and they're quite good at holding your fingertips in place, it's never actually comfortable — especially if you're actually doing lots of typing on the board. That, ultimately, makes this one hard to recommend

■ Dan Gardiner

Verdict

Hard to fault on performance, but this feels like a board designed for robots, not humans.





PC CASE

\$125 | THERMALTAKE.COM.AU

Thermaltake Core V51

Thermaltake aims for flexibility with its latest affordable PC case.

When it comes to PC cases, Thermaltake is best known for its loud-and-proud designs — ones that are made to show off the kit inside, and discretion be damned! That's been changing over the last couple of years though, and this Core V51 is a good example. With a relatively sedate design that uses a metal frame with a matte-black finish and curved edges, it's got a bit of a classic Lian Li flavour to it — and that's by no means a bad thing.

This is ultimately a case for enthusiasts, though, and that's most apparent in the transparent window in the left side, plus the ample support for water cooling: it can take radiators up to 420mm in either the top or front of the case. Flexibility is certainly the watchword with this case — you can remove all three drive cages, repositioning the two for hard drives to accommodate different fan configurations, or even strip

them out entirely and mount your drives on the back of the motherboard base plate. And it's relatively easy to work in, with tool-less installation of 3.5-inch hard and 5.25-inch optical drives alongside PCIe expansion cards.

The V51's main problem isn't actually design or quality; it's the excellent new Fractal Define R5. The latter's similarly flexible and has more premium features (noise dampening foam, more dust filters, thicker-gauge metal) that show up some elements of the V51, like its slightly-flimsy plastic drive caddies.

This is by no means a bad case, but Fractal's R5 offers better overall value.

■ Dan Gardiner

Verdict

Good flexibility, easy to work in and relatively affordable. But for \$25 more, Fractal's R5 is a better buy.



GAMING HEADSET

\$199 | AUDIO-TECHNICA.COM.AU

Audio-Technica ATH-PDG1

Great sound and long-lasting comfort? No sweat.

If, like me, your gaming rig sits in an unair-conditioned, poorly ventilated and uninsulated hot tin box of a room, the summer gaming months can be a bit... sticky, to say the least. So the last thing you want to do is wrap your noggin with an oversized pair of cans made from the hide of half a cow.

This is the second generation of AT's gaming-specific gear, though looking at it you wouldn't know. In place of the oversized cans with the slung, paddle-fit headband is the more traditional headset look-and-feel of the amazing M-series gear we've gushed over in previous issues, albeit with some slight build tweaks to keep the overall weight down. The PDG1 has slightly smaller 40mm drivers, a lighter-feeling plastic finish on the pivot points and can-exterior, plus a super-soft breathable cloth finish. The end result is a 225g headset you can wear all day long without creating a sweaty ecosystem in your ears.

The sound quality is — as always with Audio-Technica gear — nothing short of fantastic. The directional accuracy is spot on and the soundscape of these open-back cans is massive.

The PDG1 is both PC and PS4 compatible out of the box, but — as with many other headsets — Xbox users will need the MS controller attachment to get them up and running.

Three cables are included in the box. A 1.2m with goose neck mic and inline controls, a 2m PC extension cable, as well as a 1.2m smartphone cable with inline controls and mic.

A closed-back, leather-clad version is also available... for those gamers who don't mind sweating for their art.

■ Troy Coleman

Verdict

A lightweight and great-sounding open-back headset compatible with both PC and PS4.



software

» APPS FOR ALL THE PLATFORMS



Windows SOFTWARE

YNAB

Get your finances back in-line with this cloud-synced budgeting tool

US\$60 (FREE 34 DAY TRIAL WITH TRAINING AVAILABLE | YNAB
WWW.YOONEEDABUDGET.COM



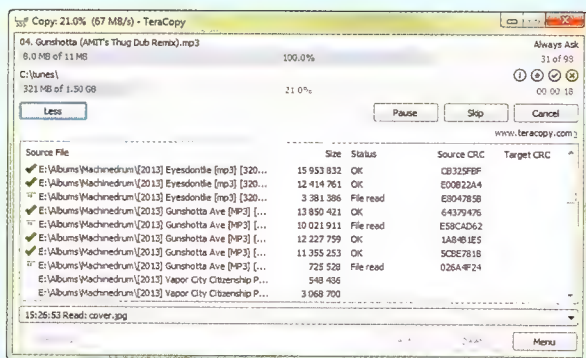
YNAB — short for 'You Need a Budget' — offers not only logical management of your finances on your PC and mobile, but also offers myriad training options, including free webinars, reading materials, and other tutorials.

YNAB differs from most other budget apps in that it gets you to think of budgets as fluid — that is, that they change throughout the month as your needs and desires change. You'll define a number of categories for your monthly spends, and a chosen amount for each category. Each time you purchase something, it is logged (the Android/iOS app allows entry at point-of-sale), and deducts from the amount budgeted for that category. However, if you come across a crazy sale, you can overspend on one category if you make

cutbacks on other spends — either that month or later.

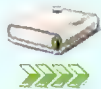
It trains you, then, to look at your categorised budget balances, rather than your bank balance, when making purchases. This is why the included training is crucial — it gets you thinking of money management as integral to every dollar you spend: can you really afford this item? Is it really worth sacrificing that holiday for?

With all this in mind, YNAB is more than just an app: it's a new way to think about your finances, making the \$60 price point trivial. **SC**

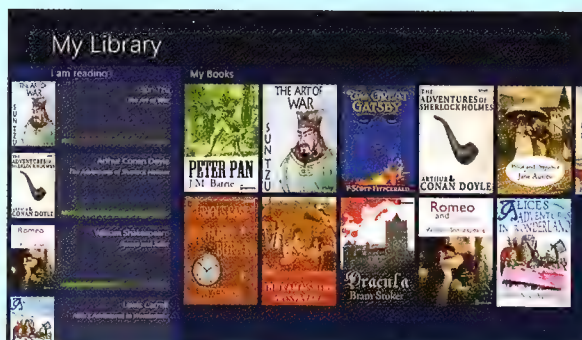


TeraCopy

FREE/\$24.95 FOR PRO | CODESECTOR | CODESECTOR.COM/TERACOPY



While the updated Windows 8.x file copying tool offers many useful improvements over the one found in previous versions, there is still a better way to handle copy/move operations, especially if you're still on Windows 7. TeraCopy installs seamlessly within Windows, taking over all of the normal copying commands and provides better control over the copying/moving of files — from warning you of errors at the beginning of the operation, as well as the handy ability to queue copy operations (improving speeds when copying multiple files to/from the same disk). It even does normal operations faster, and the Pro version can quickly copy to favourite folders, selectively copy certain file types, and remove files from the copy queue. **SC**



Book Bazaar Reader

FREE | REFRELENT SOFTWARE LAB, LLC | WWW.REFRELENT.COM



E-ink may disagree, but I love reading on tablets. Not just because you can see any illustrations in glorious colour, but, now that tablets have become the new laptops, it saves you having to carry yet another device. So, in the search for the best Windows based e-reader app, in tight contention for the lead spot is Book Bazaar Reader. Its big advantage is that it comes with in-built access to some of the biggest free and paid catalogues, including Project Gutenberg, but you can add in your own (OPDS) catalogues of choice, too. Books can also be downloaded and added directly from a URL. Its HTML5-based layout supports rich content, and it'll accept books in the standard epub, mobi, fb2, pdf, and txt file formats. **SC**



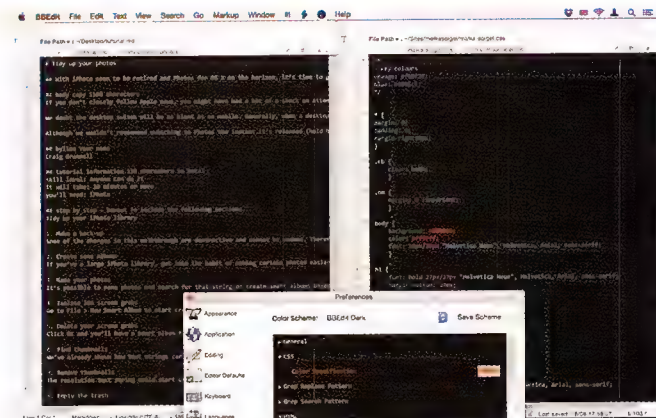
BBEdit 11

The veteran text editor gets turned up to 11.

US\$49.99 | BARE BONES SOFTWARE | WWW.BAREBONES.COM

When an app gets a new version number, you might expect a bunch of flashy new features, but simple text editor BBEdit has never been a flashy kind of app.

It fits, then, that most changes in BBEdit 11 are relatively subtle adjustments to workflow, mostly designed to enhance productivity. Fortunately, relatively minor changes can still be a big deal, as proven by the new Find Differences window; previously quite messy, it now boasts a coherent single-window view, enabling you to quickly browse a folder, check differences between files, and copy documents between folders with a single click. Another great new feature is Text Extraction within Find dialogs: you leverage BBEdit's speedy, powerful search capabilities and collate results into a new document. With a little Unix know-how, this feature is a major time-saver. Elsewhere, you'll now find rectangular text



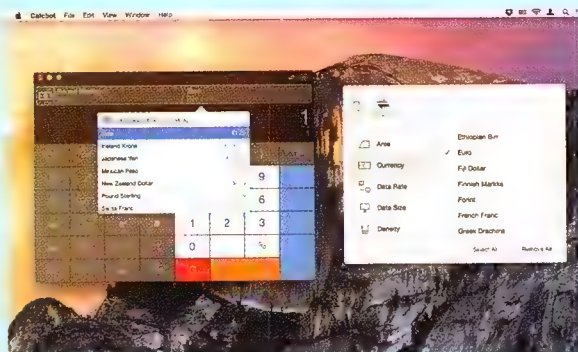
selection (via Select Up/Select Down in Edit), optional highlighting of any selected word (handy for writers and coders alike), enhanced clippings and more flexible syntax colouring. Bare Bones says the app's innards have been modernised, too, though it wasn't slow to begin with. BBEdit still isn't the prettiest app, but for efficiency and flexibility, it remains second-to-none. CG



Desk

\$37.99 | YOGG LLC | WWW.DESK.PM

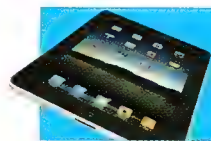
Blending a minimalist interface akin to iA Writer with broad one-click publishing support, Desk provides Wordpress, Tumblr, Movable Type, Typepad, Facebook, and Squarespace blog writers with simple space to write and post their words. The editing window is a pared-down setup, fading borders, updating reading time, word counts, and dynamically changing point size as you resize the window. Its blog tools are slick, too: you can hyperlink text, style fonts, embed video, and drag and drop images into the editing window to resize and align on the fly. Choose a platform and you've got access to published posts, draft previews and platform-specific options, like Wordpress categories, tags, slugs, and featured images. Desk is a polished and versatile writing workspace, which is on par with most minimalist writing apps.



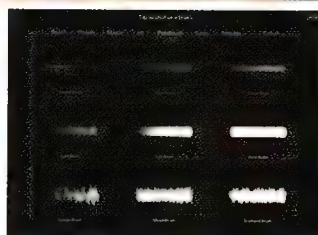
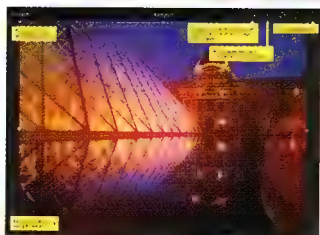
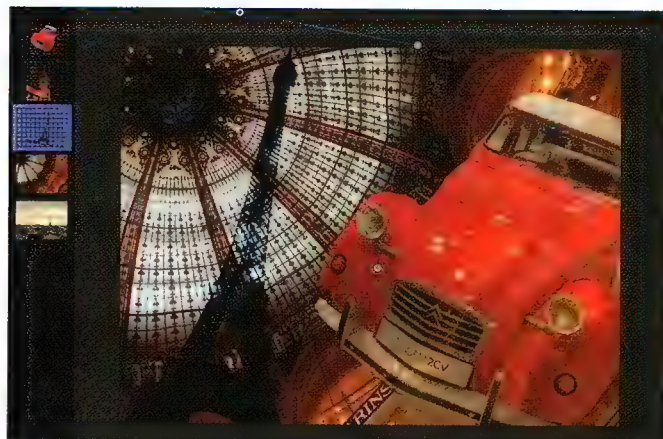
Calcbot

US\$4.99 | TAPBOTS | WWW.TAPBOTS.COM

This combined calculator/unit converter has a strong emphasis on design and usability. It boasts a basic and scientific mode, but subtly rethinks conversions and the history tape. The former can exist as a row above the main display, and you can configure which units are included; clicking the conversion provides a pop-up with further calculations. The tape replaces a memory button with favourites, which enable you to later work with a result or the expression that composed it. We also liked the expression view, showing what you've typed before hitting "equals," but it's a great pity you can't edit anything from the path in a manner similar to Souolver. Still, Calcbot is a pleasure to use and comes recommended if you don't need PCalc's power but want a better desktop calculator than Apple offers.



App Store » iOS APPS



Pixelmator

A layer-based, Photoshop-friendly editing tool for your iPad.

\$6.49 | PIXELMATOR | WWW.PIXELMATOR.COM



Pixelmator for Mac has long played second fiddle to Photoshop. But with support for layers and comprehensive collage and drawing tools, it's a far cheaper – and almost equally capable – tool.

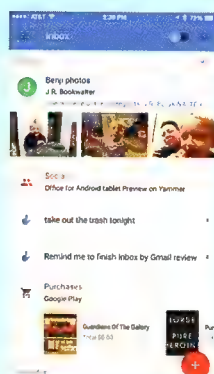
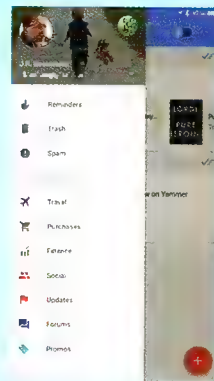
The same is now true on the iPad, where it's set to challenge Photoshop Touch. Its photo retouching tools rely on dragging control points around the screen. So, to tweak the saturation or sharpness across the whole image, all you do is drag a point around a circle. Apply a light leak or depth of field effect and you work with two points – one to position the effect and the other to handle both angle and reach. All of the canvas controls work this way, so once you've learned to use one, you can use them all. You can build up your work using layers, which really come into their own when you're compositing elements from multiple images or using the paint tools for freehand drawing. As well as the lasso and regular marquee tools, there's a magic wand that selects colours in the same way as the Instant Alpha tool in iWork – that is, the more you drag across a particular colour, the more of its associated tones are selected. Pixelmator neatly sidesteps the trap of cramming the controls onto fiddly drop-down menus by swapping out the editor view for fullscreen menus with outline graphics and, where brushes are concerned, generous stripes of each one so you can see what they do. We'd like to see these screens go further, though, with the tool previews also simulating the current size setting, as this is hard to gauge right now. But at \$6.49, Pixelmator is a steal.

Inbox by Gmail

ALSO ON ANDROID | FREE | GOOGLE | WWW.GOOGLE.COM/AU/INBOX



Many companies have tried to 'fix' email, but Google has a bold new solution that promises to be "the inbox that works for you" (though it's invite-only at the time of writing). Inbox is a new iPhone and Android app (and also available on web) with a familiar user interface that delivers a few unique twists. In addition to email, it also takes care of reminders and allows users to quickly search or snooze both. Bundles consolidate similar messages, so users can act upon everything at once, while still retaining the option to open individual emails. Highlights extracts only the most important details without having to open the email. In testing, our results varied on text-heavy emails, but photo attachments worked particularly well. We found Inbox more intuitive to use than the basic Gmail app, but neither currently is capable of managing other types of email accounts, sadly.

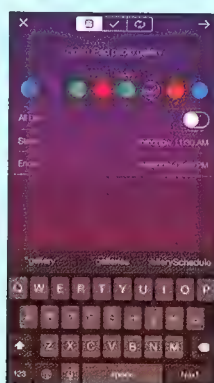
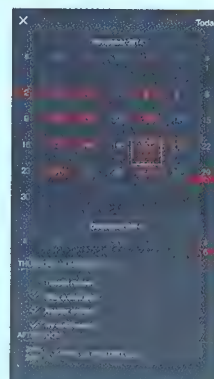


Timeful

FREE | TIMEFUL INC | WWW.TIMEFUL.COM



Productivity apps can often be too rigid about scheduling events, a problem Timeful deftly overcomes. In addition to events and to-do items, it also encourages good habits, gently helping users find time for personal goals like exercise. The app does this by proactively protecting pockets of time in your day, even on shared calendars. The UI is clean and focused primarily on the day ahead; month and list views are also available. Timeful colour-codes entries based on categories designated by the user, while also being respectful of calendar events synced from Apple, Google, and Microsoft accounts. One of our favourite aspects is the ability to drag and drop items. This simple feature makes managing the day feel less like work. Timeful also has a few tricks up its sleeve for the more obsessive-compulsive, with the ability to "sideline" less important events. You'll find after a few weeks use it gets smarter as you use it.





Google Play » ANDROID

VLC for Android

The do-all media player is now better than beta.

FREE | VIDEOLAN | WWW.VIDEOLAN.ORG



Anyone who's amassed a collection of digital video files on their PC or Mac will know just how invaluable VideoLAN's open-source VLC media player is. Able to play almost any codec and format under the sun, the self-contained player is also available on almost every platform, which now officially includes Android.

After two years on the Google Play store in beta form, the Android version of VLC has finally graduated to version 1.0.

The change is more of a formality than a big revision, with the app's move out of the beta phase giving VideoLAN the opportunity to announce VLC for Android as a more stable version of what was already there before.

The upgrade to version 1.0 comes with some added bug fixes for Android Lollipop 5.0 and devices using newer ARMv8 processors. If you have a recently released Android device, you should now be fully supported.

Chromecast streaming support is still sadly missing though, despite being announced as in development in back in June 2014. SL



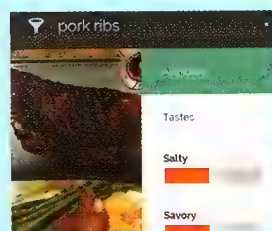
Horizon

FREE WITH IAP | HORIZON VIDEO TECHNOLOGIES | WWW.HORIZON.CAMERA



Ever attempted to film a friend doing something cool outdoors using your smartphone? You pretty much have to be James Cameron to get a phone-shot video that's not painful to watch. But

Horizon (available for iOS too) has straightened up phone photos and videos. It works by taking a portion of your smartphone camera's visible area and uses your device's inbuilt gyroscope to keep this selection level, no matter what orientation the phone ends up in. It lets you straighten photos and videos in real time, so you don't have to spend hours cropping photos and you can easily produce videos that don't give viewers vertigo. Stelios Petrakis, Horizon's CEO and cofounder, has the ambitious goal to make Horizon the default way to shoot videos on phones. With three video-resolution options, a selection of filters and the unique ability to keep videos smooth and flat, Horizon may actually be good enough to achieve it. Definitely worth a sideways look. JB

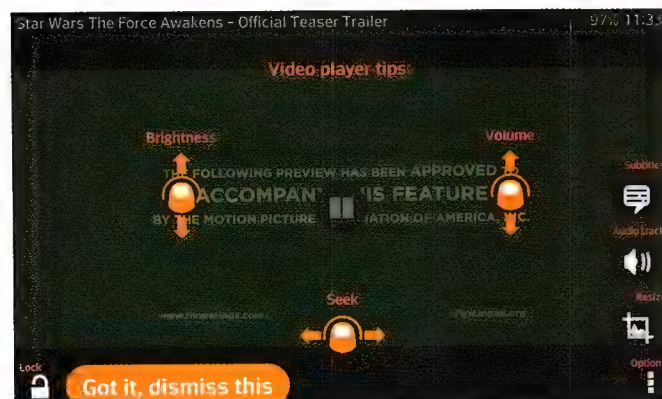
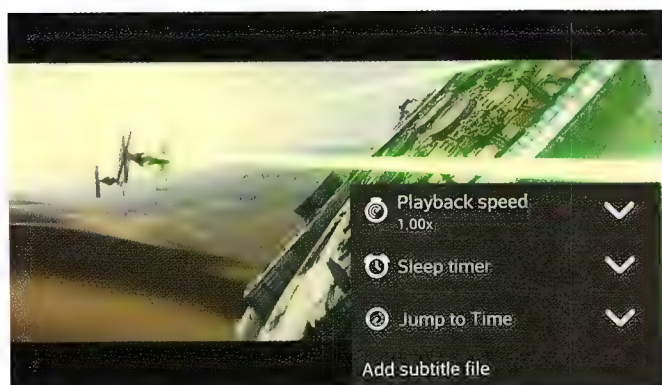


Yummly Recipes & Recipe Box

FREE | YUMMLY | TINYURL.COM/KEUPP3H



Over a million recipes are at your fingertips with Yummly, a crowd-sourced foodies' delight that gives you personalised recommendations of mouth-watering meals and drinks. Browse recipes by scrolling through the app's beautiful food images, and select a meal to see the recipe and its nutritional value. You'll be hard pressed to stop at one recommendation, so Yummly lets you add meals to your list of 'Yums' for later perusal. The thing that sets Yummly apart from its competitors is just how customisable its search functionality is. Do you have dietary requirements? Yummly smartly bases its search results on what you can actually eat, and skips the stuff you can't. You can even refine your searches by tastes! Dessert fans are going to have a tough time keeping that 'Sweet' slider at a reasonable level. Yummly on Android is oddly missing the iOS version's ability to create shopping lists, but even without this feature, this is a highly recommended recipe app. SL



Windows Store » WIN PHONE 8

Chronos Calendar + Another way to stay organised.

\$1.99 | CHRONOSPHERE | TINYURL.COM/K4E3Y5N



Chronos Calendar+ offers a markedly better experience for navigating a busy schedule compared with Windows Phone's default Calendar app. Not only does it offer three times as many calendar layouts – including an excellent split screen layout that combines a today view with a full week view – but it comes with a handy quick add feature for entering new appointments.

You simply enter all of the appointment specifics in a single line, and it parses them into the relevant appointment fields. We'd like to see the quick add feature beefed up by adding support for natural language parsing in a future app release (as it is, you have to enter all of the appointment details in a specific order, and it doesn't recognise dates), but the app is still well worth the two bucks once you factor in the beautiful design, built-in holidays, support for scaling to different screen res's, and the live tile customisation. JO

DECEMBER 2014

today
15
Monday
w.51 | d.349

Tanya Nehl's birthday

DECEMBER 2014

15 51 MON	16 TUE	17 WED	18 THU	19 FRI	20 SAT	21 SUN
Tanya Nehl's birthday	Heather Murphy's birthday	Emma Mikus's birthday				Logan Booker's birthday

GFX DirectX Compare

1080p Fill Offscreen
Measures the device's texturing performance by...

Your Device's Best Score 619
MTexel/s

Motorola Droid Turbo

GFXBench 3.0

FREE | KISHONTI INFORMATICS | [HTTP://GFXBENCH.COM](http://GFXBENCH.COM)



The plight of every early adopter and is always wanting to know how much better (or worse) your current gadget is compared with everything else on the market. With the debut of

GFXBench 3.0 on Windows Phone, users can finally pit their device against Android and iOS smartphones to see how they stack up. GFXBench 3.0 is a utility that's widely used for testing smartphones using a range of benchmarking tests that measure graphics performance, render quality, power consumption and stability. Depending on how powerful your device is, some of the tests may not be available to run. On the Nokia Lumia 830, for instance, the high-level graphics and rendering tests weren't available. Once it's complete, you can download the GFXBench database to see how your device compares to all the others that have completed the test. Just don't expect your device to come off well against its iOS and Android counterparts – the Nokia Lumia 820 consistently ranked at the bottom of the pile. JO

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Hanyu.co

FREE | SPIFFY VENTURES | WWW.HANYU.CO



Between the recent free trade agreement with China and it having just overtaken the US as the world's largest economy, it's never been a better time to learn Mandarin. Hanyu.co is a feather in the cap of Windows Phone die-hards, having launched on this platform ahead of the 'coming soon' iOS app. It isn't as interactive as the excellent Duolingo language learning app (which also recently debuted on Windows Phone), as you have to guide yourself through the various exercises, and it uses the standard flashcards approach for practicing basic words and phrases. Still, with the integrated audio and support for pinyin (the official phonetic system for transcribing Mandarin pronunciations of Chinese characters) and the integrated points system, it's a great, well-designed app for learning a new language if you're motivated enough to do the lessons properly. New lessons and courses are added on a regular basis, and you can sync your progress across other Windows devices and the web. JO

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Solid-state superstars

When it comes to storage, just how fast is fast enough? Lindsay Handmer puts 23 of the latest SSDs on test to find out.

In recent years SSD prices have plummeted to the point that they are actually an affordable upgrade for your average PC – not just those chasing high end performance. Even the slowest models are a lot faster than traditional HDDs and vastly improve tedious aspects such as slow boot ups and laggy app launches. For now SSDs are still a capacity game – users tend to buy whatever has the best GB to dollar ratio and not worry too much about the extras. Many companies actually use the same controllers and NAND memory and performance does not always vary hugely across the board.

While manufacturers have announced larger capacity SSDs (2TB and more), for storing a lot of files a mechanical HDD is still a much more affordable option. This looks set to change in the future though, as SSD production volume increases lead to lower prices. Once important driver is enterprise use – companies running servers and handling a lot of data are increasingly switching to SSDs for the higher reliability and lower operating costs.

New technologies are also set to shape the future of the SSD. Manufacturers are constantly shrinking their memory cells in size – fitting more storage per chip as well as lowering costs. Smaller flash causes its own problems (such as reduced life) which means other options have become more attractive. Samsung has already taken the lead and released SSDs based on 3D V-NAND technology that stacks flash cells vertically, opening up a new avenue of affordable size growth with fewer drawbacks. Intel is set to launch a similar technology in 2015 and SSD sizes of 10TB could be possible in the next 5 years.

Many current drives already outstrip the 6Gbps of bandwidth available from SATA 3, but there are other connectivity options. SATA Express taps into PCIe lanes for faster

speeds, while M.2 brings the same bandwidth improvements to a smaller form factor popular with laptops. We are also starting to see PCIe-card SSDs increase in popularity.

HOW WE TESTED

To make sure our test setup had no bottlenecks that could slow SSD performance, we put together a high end machine. It has an Intel Core i7-5960X CPU running in an ASUS X99 Deluxe motherboard, cooled with a Cooler Master Nepton 140XL closed loop water cooler. It has 16GB (4 x 4GB) of Kingston HyperX 3000MHz DDR4 and uses a 512GB Samsung 850 Pro SSD as the main drive. Graphics are

"New technologies are also set to shape the future of the SSD. Manufacturers are constantly shrinking their memory cells in size - fitting more storage per chip as well as lowering costs."

provided by a Radeon R9 295x2.

Direct read and write benchmarks were performed on a clean drive with AS-SSD and CrystalDiskMark. Sequential read and write tests give an idea of the maximum throughput an SSD can sustain. While not common in normal use, this is important for uses such as video editing. Random 4K read and write tests give a much more accurate idea of how the drive will respond to day to day use. We also used the AS-SSD program copy benchmark to evaluate typical file transfers speeds across the range.



**BUDGET SSDs:
240GB & 256GB**



\$189 | WWW.AMD.COM

\$139 | WWW.APACER.COM

\$139 | WWW.CRUCIAL.COM

\$160 | WWW.INTEL.COM

AMD Radeon R7 SSD (240GB)

A brand gamers know they can trust.

Built out of a partnership with OCZ, the R7 puts the Barefoot 3 M00 controller and Toshiba 19nm MLC NAND to work. AMD is not trying to reinvent the SSD here – rather the aim is to make it easy for users to pick an entire system out under the AMD moniker. Performance is good, but realistically we might have hoped for a touch more based on the price. The R7 supports AES 256-bit encryption, as well as RAID, but not low power states. It's backed by a four year warranty that includes up to 30GB a day of data writing – a step up from the basic 20GB a day of cheaper models. You can also get the R7 as a smaller 120GB drive or a larger 480GB model.

Verdict

A slightly longer than usual warranty helps makes the R7 a good though not spectacular buy.



Apacer Pro II Series AS510S (256GB)

Sometimes average is great.

Packing the full 256GB of storage into a standard 2.5-inch 7mm form factor, the AS510S is a bit of an unknown. Apacer don't detail the exact controller or memory in the Pro II series, but we know it does use a module from Phision and MLC NAND. It's not the fastest SSD here, nor is it the slowest. On the plus side it is one of the more affordable models. The Pro II series supports 256-bit AES encryption, as well as DEVSLP mode to cut down on power use and extend your laptop battery life. The AS510S is backed by a three year warranty and has solid 67 TBW endurance. As well as the larger 480GB model, you can also get a smaller 64GB and 128GB ProII SSD.

Verdict

Not as well-known as other brands, the Apacer SSD nonetheless offers decent bang for buck.



Crucial MX100 (256GB)

A universally well regarded SSD.

The MX100 uses 16nm MLC NAND from Micron coupled to the same Marvell 88SS9189 controller found in the higher end M550 SSDs – enabling both low power states and AES 256-bit encryption. During testing we saw a few slightly slower than ideal results, though in normal use the MX100 is actually very quick and offers excellent performance for the price. The MX100 also has plenty of endurance, with a 72 TBW limit. While the warranty is only the typical three years, that means you can write 65GB a day, or 40GB a day for 5 years. If you want a smaller, cheaper option, the MX100 comes in 128GB model that can be found for as little as \$85.

Verdict

The MX100 is a great upgrade option thanks to its strong overall speeds and bargain pricing.



Intel SSD 730 Series (240GB)

Performance from a trusted name.

Using Intel's controller and 20nm MLC NAND flash, the 730 series is RAID ready and has a nice long five year warranty. Intel has factory overlocked the controller from 400MHz to 600MHz and the NAND bus speed runs at 83MHz. Not surprisingly the Intel SSD is in the upper echelons of speed, but still gets beaten by a few competitors. You will need a SATA 3 port to get the full performance as it will max out the bandwidth available on SATA 2. The Intel drive has excellent endurance (up to 70GB a day) to give peace of mind about long term or heavy use. For those who need extra space, you can also get the 730 series in a larger 480GB version.

Verdict

A fast SSD with excellent endurance and backed by a 5 year warranty.





Kingston HyperX 3K (240GB)

Should you sacrifice flexibility for performance?

The HyperX uses the SandForce SF-2281 controller driving Intel 25nm MLC NAND. You can get it as a bundle kit that includes an enclosure and bracket, but it's not worth the extra cost. Performance is reasonable – more so when you consider the price. The HyperX is 9.5mm thick, which means while it will install fine in a standard 2.5-inch bay, it won't fit in newer 7mm slots. The drive doesn't have a day to day endurance rating, but does have a three year warranty and a 765TB total data written limit. Like most SSDs, the HyperX also comes in both a 120GB and a 480GB version, though the 240GB model is the sweet spot in terms of GB to dollar ratio.

Verdict

A few minor downsides slightly mar an otherwise excellent drive.



Kingston SSDNOW KC300 (240GB)

Available with an upgrade bundle kit.

Pairing the SandForce SF-2281 controller (running an optimised firmware) with Toshiba 19nm MLC Flash, the KC300 comes as a standalone drive or an upgrade kit bundled with some extras (for about \$20 more). This includes mounting brackets, a handy USB 2.0 enclosure, drive cloning software and SATA cables. The KC300 supports low power states, RAID and 128-bit AES encryption. It's backed by a three year warranty, with 765TB of total data writing endurance. You can also get a 480GB drive as well as a smaller 120GB model. Unusually, Kingston also offers a 180GB drive (and a 60GB) but these are barely any cheaper.

Verdict

A decent bundle of extras and great performance but a little pricey.



OCZ Arc 100 (240GB)

A budget offering that doesn't skimp on speed.

The ARC 100 uses Toshiba's 64GBit 19nm MLC NAND, coupled to the Barefoot 3 M10 controller running at 352MHz. Performance is strong and the drive makes good use of your SATA 3 connection. Considering the cheap price, the SSD is aimed at the everyday and gamer crowd. The ARC 100 does support encryption and RAID, though won't handle low power states. OCZ rate the drive for an endurance of 20GB a day, with a three year warranty. While not stand out, that is plenty for normal use and you should easily get more than 3 years from the drive. You can get the ARC 100 in a 120GB version that is a touch slower, while the 480GB model is a little faster.

Verdict

Deceptively ordinary, the ARC 100 combines budget performance with a robust feature set.



OCZ Vector 150 (240GB)

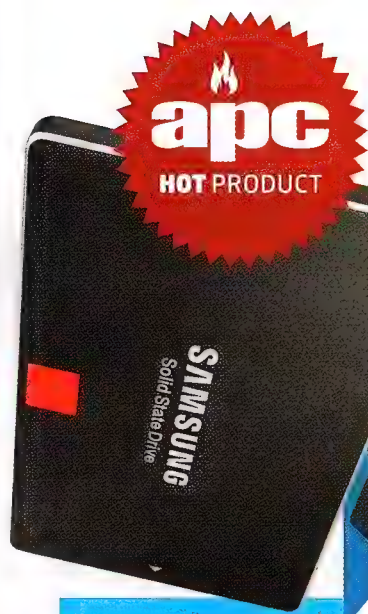
Is it worth paying extra?

A step up from more budget OCZ offerings, the Vector 150 adds new features and performance. It uses 19nm Toshiba MLC NAND coupled with the Barefoot 3 M00 controller and while the read and write speeds are better than its cheaper OCZ siblings, it's not enough that you'll notice a difference for normal use. Instead the Vector 150's advantage is endurance – it's rated for 50GB of usage a day and has a five year warranty. It also supports 256-bit AES encryption, as well as RAID but no low power mode. The drive comes with a 3.5-inch desktop adaptor and a key for the Acronis True Image HD cloning software to make setting up your new drive easy.

Verdict

A solid step up for those who need a little more from their SSD than the budget offerings provide.





\$210 | WWW.SAMSUNG.COM



\$119 | WWW.SANDISK.COM



\$155 | WWW.SEAGATE.COM



\$131 | WWW.SILICON-POWER.COM

Samsung 850 Pro (256GB)

Integrating the very latest technology.

The secret behind the 850 Pro is 3D NAND, where stacking the cell layers vertically lets Samsung build bigger drives more efficiently, while also improving performance. Even better, endurance gets a boost too — the 850 Pro is rated to handle 150TB of data, or 40GB a day for the entire 10 year warranty. The drive also uses less power and supports both RAID and disk encryption, not to mention giving you the full 256GB of space. In use the 850 Pro is a speed demon, but you pay more for the extra performance. You can get the 850 Pro in 128GB, 512GB or 1TB sizes. It's worth noting that the bigger drives offer a better dollar to GB ratio.

Verdict

High end performance and cutting edge features not available anywhere else.



SanDisk Ultra II SSD (240GB)

Can you get bang for buck without sacrificing bandwidth?

The Ultra II provides very solid performance, but once you factor in the price it becomes a real stand out. In fact, the 240GB we tested offers one of the best GB-to-dollar ratios here. The Ultra II is the first SSD outside of Samsung to use TLC NAND memory and mates it with a Marvell 88SS9190 controller. No endurance rating is given for the Ultra II, though you can expect it to handle normal use without trouble. If you specifically need high endurance, SanDisk has other suitable SSDs. You can also get the Ultra II as 120GB, 480GB and 960GB models. No support is available for encryption, but you can run the drives in RAID.

Verdict

At under \$0.50 a GB and with very respectable speeds you can't go wrong with the SanDisk Ultra II.



Seagate 600 SSD (240GB)

Does traditional HDD knowledge help build a better SSD?

Combining Toshiba 19nm Type C Toggle-mode MLC flash and a LM87800 controller chip sounds good, but the Seagate 600 tends to over promise and under deliver. Performance isn't bad as such, just a little low considering the price. The Seagate Endurance rating is 40GB a day and is backed up by a three year warranty, but only up to a maximum of 70TB. This actually works out to be almost five years at 40GB a day, so you could write up to 64GB a day during your 3 year warranty period. For those after more or less space, the Seagate SSD comes in a 480GB and a 120GB model. You can also get the Seagate 600 in an extra thin 5mm version in all sizes except the 120GB.

Verdict

Head for greener pastures unless you can pick it up for a song.



Silicon Power S60 (240GB)

A budget conscious SSD upgrade

Plain black and fitting into the standard 2.5-inch, 7mm thick form factor, the S60 is designed to affordably bring your computer up to date. Performance is a little slower than the top tier, but considering it's competing against budget drives it offers excellent bang for buck. Of course this means it doesn't have all the bells and whistles — such as no AES Encryption or low power state support. Silicon Power rates the drive for a total data write of 650TB and back it up with a three year warranty. For those who want more storage, the S60 ships as a large 480GB model. It's also available as a 120GB and 60GB capacity drive, though offers better value in the larger sizes.

Verdict

A basic upgrade that will add performance without blowing out your budget



MIDRANGE SSDs:
480GB & 512GB



\$320 | WWW.CORSAIR.COM

\$259 | WWW.CRUCIAL.COM

\$399 | WWW.SAMSUNG.COM

\$299 | WWW.SANDISK.COM

Corsair Force LX (512GB)

Delightfully consistent.

The LX Series uses a Silicon Motion SM2246EN controller coupled with Micron 20nm NAND flash. We had hoped that performance would be a little faster, but generally the LX series gave good, consistent data rates. No endurance information is given, but the drive has a three year warranty. The Corsair SSD supports encryption as well as DEVSLP low power states, which helps preserve your laptop's battery. Included is access to the Corsair SSD toolbox, which has some handy software. While we tested the largest 512GB drive, the LX series also comes in 256GB and 128GB models. The 256GB is the best value.

Verdict

While it does not stand out in any way, the Corsair LX Series offers decent all round value.



Crucial MX100 (512GB)

Get it while it's hot.

The Crucial MX100 walks the fine line between performance and affordability. Helping cut costs is Micron's new 16nm MLC NAND – one of the smallest sizes out there. The MX100 uses the popular Marvell 88SS9189 controller which supports AES 256-bit encryption as well as low power states. Despite the affordable price for the size, the MX100 512GB offers better than average performance. It's backed by a three year warranty and has a 72TBW endurance – equating to 65GB a day for three years. The MX100 series is only available up to 512GB and users who want more capacity need to look to the M550 range for up to 1TB.

Verdict

A bang for buck price coupled with above average performance makes the MX100 a winner.



Samsung 850 Evo (512GB)

The latest in SSD technology from a leading brand.

Only just launched in Australia, the new drive from Samsung combines the 32 layer 3D V-NAND from the 850 Pro with the slightly more affordable pedigree of the Evo line. It's the fastest SATA SSD we've tested – sure, there are a few results where other drives sneak ahead, but overall the 850 Evo is the winner. It also has a five year warranty and a 150 TBW endurance. It includes important extras such as 256-bit encryption and low power state support. At the time of writing there was no street price for the EVO, but based on the RRP it's a very competitive offering for those chasing performance. You can grab one in 120GB, 250GB, 500GB and 1TB flavours.

Verdict

Big performance and big features make this one worth the big price tag.



SanDisk Extreme Pro SSD (480GB)

High end with a mid-range price tag.

Aimed at higher end users, the Extreme Pro uses SanDisk's own 19nm MLC flash coupled with a Marvell 88SS9187 controller. It's backed by an impressive 10 year warranty, and while still decent, the endurance is nothing special. You can write a total of 80TB, or 22GB per day for 10 years, which is plenty for most users. While it does not support encryption, you can run RAID setups for increased performance and the drive features SanDisk's nCache technology. As expected, read and write speeds are excellent and it was one of the faster drives we tested. The Extreme Pro series also comes in a smaller 240GB drive and a larger 960GB capacity.

Verdict

Strong performance but lacking a few features.





\$299 | WWW.TOSHIBA.COM

Toshiba Q Series Pro SSD (512GB)

A good buy if you can find it.

The Q series used 19 nm MLC NAND Flash that's actually produced by Toshiba, so not surprisingly the drive is pretty fast. That said, while it can beat out some of the cheaper options, there are still faster drives around. Toshiba don't give an endurance rating for the drive, though based on the three year warranty you can expect it to handle at least 20GB a day of data writing. The drive also includes a free (downloadable) copy of NTI Echo – a software package that makes it easy to clone your old drive over to the SSD. If you can pick up the 512GB Q Series for a cheap price then it's a great upgrade, though it can be hard to find and is often fairly expensive.

Verdict

Not quite high end yet not bang for buck either.



\$259 | WWW.TRANSCEND.COM

Transcend SSD 370 (512GB)

A great price to GB ratio.

With a full 512GB of storage available, the Transcend drive aims to bring high capacity SSD performance in a more affordable package. Read and write speeds are pretty good – those chasing every extra MB/s might be disappointed, but for normal use the SSD370 is fast enough. The 370 comes with Transcend's SSD Cope – software that monitors your wear status, enables TRIM and updates the firmware. In the packet you also get a 2.5- to 3.5-inch bracket to make mounting easier. It has a three year warranty, unless the software shows its reached its wear out point. Which is fine, except Transcend don't actually supply the endurance numbers.

Verdict

An affordable package well suited to mid-range users.



TITANIC SSDs: 1TB



\$589 | WWW.CRUCIAL.COM

Crucial M550 (1TB)

Large and in charge.

The M550 uses the popular Marvell 88SS9189 controller to handle 20nm Micron MLC NAND Flash. Performance is top notch, and the Crucial drive is one of the fastest we tested. It's particularly speedy in tests that reflect well for real world use. As expected from a higher end drive, the M550 supports both AES 256-bit encryption and DEVSLP low power states. It's also got a three year warranty and a standard 72TBW endurance – about 40GB a day. While we went for the largest M550, it actually comes in a wide variety of sizes and form factors. You can get it in 128GB, 256GB and 512GB flavours and in super thin 5mm drive, the standard 7mm or even mSATA or M.2.

Verdict

High performance with slightly high price tag, the true value of the M550 lies in its versatile options.



\$459 | WWW.SAMSUNG.COM

Samsung 840 EVO (1TB)

Can the former king hold its own?

Now a generation old, it doesn't feature 3D V-NAND – instead it has vertically stacked TLC NAND which still offers some of the best performance around. Of course it is slower than the Pro, but it's also a lot more affordable. With the launch of the new 850 EVO, the older 840 should see some very nice price drops that will make it an even better deal. Samsung don't give a specific endurance for the drive, though do back it up with a three year warranty. The drive also supports encryption and low power states. For those who need a different capacity, the 840 EVO comes in a tiny 120GB version, as well as 250GB, 500GB plus a fairly unusual 750GB model.

Verdict

An excellent all round performer with a surprisingly reasonable price tag.





"The KC300 comes as a standalone drive or an upgrade kit bundled with some extras (for about \$20 more). This includes mounting brackets, a handy USB 2.0 enclosure, drive cloning software and SATA cables."

SSD BENCHMARKS

	AS-SSD - SE- QUENTIAL READ/ WRITE (MB/S)	AS-SSD - 4K READ/WRITE (MB/S)	AS-SSD - PROGRAM COPY (MB/S)	CRYSTALDISK- MARK - SEQUEN- TIAL READ/ WRITE (MB/S)	CRYSTALDIS- KMARK - 4K RANDOM READ/ WRITE (MB/S)	PRICE	SIZE (GB)	COST PER GB (LOWER IS BET- TER)
240 & 256GB SSDs								
SAMSUNG 850 PRO	512.22 / 449.24	29.23 / 90.06	256.11	524.7 / 491.8	32.90 / 103	\$210	256	\$0.82
APACER PRO II	479.51 / 415.84	23.31 / 98.98	236.97	501.2 / 445.5	22.25 / 96.36	\$139	256	\$0.54
CRUCIAL MX100	512.64 / 330.15	25.34 / 94.07	234.04	494.3 / 344.4	28.04 / 118.8	\$139	240	\$0.58
OCZ ARC 100	441.86 / 409.93	23.27 / 102.38	223.02	422.1 / 429.9	25.4 / 113.8	\$120	240	\$0.50
SANDISK ULTRA	515.23 / 450.90	29.16 / 90.20	245.8	517.6 / 473.1	32.02 / 112.6	\$119	240	\$0.50
AMD RADEON R7	491.58 / 302.87	24.61 / 85.12	220.49	499.3 / 305.1	22.99 / 93.83	\$189	240	\$0.79
INTEL 730 SERIES	503.81 / 274.60	28.72 / 90.02	228.57	461.7 / 288.7	31.78 / 101.7	\$160	250	\$0.64
KINGSTON HYPERX	488.92 / 365.84	22.94 / 91.05	245.23	491.7 / 391.7	27.8 / 99.8	\$149	240	\$0.62
KINGSTON KC300	502.36 / 441.19	24.17 / 88.78	260.3	504.6 / 456.6	29.11 / 96.84	\$200	240	\$0.83
OCZ VECTOR 150	501.04 / 481.43	21.41 / 102.80	257.63	505.1 / 492.4	23.67 / 118.7	\$180	240	\$0.75
SILICON POWER S60	495.79 / 305.32	27.30 / 85.17	219.64	514.4 / 314.0	23.65 / 92.50	\$131	240	\$0.55
SEAGATE 600	491.97 / 434.82	24.19 / 83.13	212.16	499.1 / 458.4	22.64 / 91.32	\$155	240	\$0.65
480GB & 512GBs								
SAMSUNG 850 EVO	503.1 / 489.77	35.03 / 104.66	274.53	508.7 / 493.1	40.19 / 119.0	\$399	500	\$0.80
CRUCIAL MX100	509.51 / 468.18	25.27 / 92.49	250.01	487.9 / 472.5	27.96 / 114.4	\$259	512	\$0.51
CORSAIR FORCE LX	504.86 / 354.22	28.87 / 90.81	261.91	510.5 / 399.0	23.66 / 99.8	\$320	512	\$0.63
SANDISK EXTREME PRO	510.11 / 475.03	29.01 / 88.90	268.88	516.7 / 484.9	32.28 / 108.8	\$299	480	\$0.62
TOSHIBA Q SERIES	508.81 / 477.38	19.86 / 88.78	272.09	511.4 / 478.1	22.41 / 98.46	\$299	512	\$0.58
TRANSCEND SSD 370	514.75 / 391.08	23.65 / 92.61	241.04	517.7 / 419.5	26.22 / 108	\$259	512	\$0.51
ITBs								
CRUCIAL M550	512.65 / 485.40	30.58 / 99.45	273.89	5.6.2 / 492.9	35.90 / 114.8	\$589	1000	\$0.59
SAMSUNG 840 EVO	502.89 / 489.68	33.08 / 90.87	270.52	507.1 / 491.0	36.21 / 113.3	\$459	1000	\$0.46
NEXT-GEN SSDs								
KINGSTON M.2	490.66 / 455.28	25.67 / 95.61	256.9	508.9 / 478.2	27.98 / 103.04	\$150	120	\$1.25
OCZ REVODRIVE 350	1439.4 / 901.27	20.29 / 47.44	395.05	972.7 / 808.0	25.8 / 88.2	\$1,100	480	\$2.29
SAMSUNG XP941	1075.72 / 875.66	29.44 / 102.12	338.13	953.5 / 873.6	33.41 / 133.4	\$605	512	\$1.18

Next-gen solid-state drives

Today's SATA 6Gbps SSDs are amazingly fast, but are they about to be made redundant by newer form factors and interface standards?



\$150 | WWW.KINGSTON.COM

\$1,100 | WWW.OCZ.COM

\$605 | WWW.SAMSUNG.COM

Current SSDs are already maxing out the bandwidth available to SATA 6Gbps, so it's no surprise that manufacturers are experimenting with faster interfaces. Part of the SATA 3.2 standard, SATA Express taps into the high bandwidth available from PCIe yet joins multiple SATA connectors together in a way that remains backwards compatible with existing drives. While many new motherboards include SATAe, we don't yet have SSDs that support it. What we have right now instead is SSDs built on boards that plug directly into PCI slots. Typically much more expensive than a standard drive, PCIe SSDs can offer up to three times the performance. Also gaining in popularity are M.2 SSDs — a small form factor implementation of the SATAe interface. Not only are these drives physically smaller, they can offer higher speeds than traditional SSDs. M.2 is well suited to laptops, though many of the latest desktop motherboards include a connection. You can also plug M.2 SSDs into carrier boards that then slot into PCI ports. For now most of the M.2 SSDs available use the SATA 6Gbps standard, so don't actually run any faster than a normal SSD, though they are smaller and don't need any cables.

Kingston SM2280S3 M.2 (120GB)

Is this tiny SSD worth the sticker shock?

The 120GB Kingston M.2 module measures in at a tiny 22mm wide and 80mm long and supports 256-bit AES encryption and low power states. It's backed by a three year warranty and has an endurance of 230 TBW, or around 20GB a day. The downside to the Kingston drive is that it uses the SATA 3 standard and is no faster than any other SSD in our roundup. The M.2 form factor is great if you have a compatible laptop, but for a desktop you can get the same performance and twice the capacity for the same price if you opt for a regular SSD.

Verdict

Great for laptop or mini PC use otherwise a standard SSD offers a much better deal.



OCZ RevoDrive 350 (480GB)

Is owning the future of SSDs worth the price?

Skipping the whole SATA interface, the RevoDrive plugs directly into a PCIe slot. Inside the SSD is a wondrous array of Toshiba 19nm MLC NAND chips and four SandForce SF-2200 controllers. It's actually set up as a SATA 3 RAID array that then feeds through a PCIe 2.0 8x interface. The result is loads of speed, especially when doing sequential file transfers. For normal use though the drive doesn't have quite as big an advantage. The RevoDrive is covered by a three year warranty and an endurance of 50GB a day. You can also get the RevoDrive in a 240GB and 960GB model.

Verdict

Cutting edge, but you can get similar performance and more space from an SSD RAID array.



Samsung XP941 (512GB)

How far will you go for bandwidth?

In contrast to most M.2 SSDs on the market, the XP941 uses a PCIe x4 interface, not SATA 3. This means it can take advantage of the extra bandwidth and let the NAND run at its full potential. No wonder then that it is super-fast — offering around double the performance of SATA 3 for sequential data. The XP941 is an interesting look at the future of SSDs, but for now it's just not cost effective for a desktop PC. The SSD would be very handy in a portable machine (despite the price) but currently there are very few laptops that support M.2 PCIe.

Verdict

Great performance but not yet enough platforms using PCIe M.2 SSDs





Real world SSD performance

Is it worth spending the extra money to buy the fastest SSD available?

It's all well and good to look at performance benchmarks and pick a drive based solely on speed, but how much of a difference does it make in the real world? To find out, we took the fastest SSD and the slowest SSD from our roundup and put them through a battery of real world tests. We ran the drives in both an Acer Aspire laptop and our high-end desktop test machine (under Windows 8.1) to see how the surrounding hardware would change our result.

TEST REGIME

We tested first with our synthetic benchmarks, AS-SSD and CrystalDiskMark. We then tested *Company of Heroes 2* gaming performance as well as load times. Finally we tested Adobe Photoshop install times and well as how long the system's took to boot. Each timed test was run five times (discarding any really odd results) and the results averaged. Note that the results for the laptop are lower due to less powerful hardware. The important metrics are the comparison between the SSDs on each machine.

"Our high end machine could push our SSDs hard and the faster drive was demonstrably better. Even so, unless you are chasing the very highest performance, the difference is fairly small."

DESKTOP PC RESULTS

So can you notice the difference between the fastest and slowest SSD? Yes, there is a slight but noticeable difference on both machines. Keep in mind though that the differences in speed are only important in some situations but are more apparent on the faster desktop. Boot times saw no real difference between the two SSDs — with this level of drive, the access speeds are not the bottleneck.

The same went for app and game load times — there was significant variation between the runs, but on average the faster drive was only a smidge quicker. That said, if we had not been timing it we would not have noticed the difference and other factors (such as other programs being open) will account for bigger differences. General snappiness and the 'feel' of the system was the same between SSDs.

LAPTOP SPEED

On our laptop the difference between the high end and the lower end SSD is less apparent and will make no appreciable real world difference — the SSD is simply not the bottleneck and is not being pushed to its limits. Our high end machine could push our SSDs hard and the faster drive was demonstrably better. Even so, unless you are chasing the very highest performance, the difference is fairly small.

The faster SSDs tested tend to have better endurance and longer warranties, and this is where the true value lies. If you need a highly reliable drive and use applications that write a lot of data (such as video editing) then the higher speeds and longer life can be worth the increased cost. ■

LABS TEST: REAL WORLD SSD PERFORMANCE

	PCMARK 8 STORAGE (SCORE)	PCMARK 8 STORAGE (MB/S)	COMPANY OF HEROES 2 (AVERAGE FPS)	COMPANY OF HEROES 2 (LOAD TIME)	WINDOWS 8.1 BOOT SPEED (SECONDS)	ADOBE PHOTO-SHOP INSTALL TIME (SECS)	ADOBE PHOTO-SHOP LOAD TIME (SECS)
DESKTOP PC							
SAMSUNG 850 EVO	4,984	278.16	46.21	13.95	30.1	87.3	2.8
SEAGATE 600	4,805	270.44	45.98	14.85	30.3	91.4	3.1
LAPTOP							
SAMSUNG 850 EVO	4,756	142.66	17.22	23.9	34.3	128.9	6.9
SEAGATE 600	4,721	142.02	17.41	24.1	35.1	130.1	7



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Hybrid drives: a realistic SSD alternative?

What happens when you combine an SSD and traditional hard drive? Lindsay Handmer is about to find out.

SSDs offer excellent read and write speeds (and command a price premium) but affordable models don't yet come in capacities above 1TB. Mechanical hard drives are a lot cheaper per GB, but are also a fair bit slower. To capture the advantages of both, vendors like Seagate and Western Digital have built hybrid drives that combine SSDs and hard disks. Hybrid drives feature a chunk of fast NAND flash – basically a mini SSD, with sizes from as little as 8GB up to 120GB. In larger sizes the SSD might operate in a standalone fashion, while in smaller sizes the drive will automatically cache commonly-used data on the SSD, boosting performance.

You don't have to configure the drive for caching either – it works out what files you use most and keeps them stored on the SSD. This typically boosts boot times and lowers load times for commonly-used programs. While not as quick as an SSD, a hybrid drive can give SSD-like performance in many situations.

The real advantage of hybrids is cost, (especially for larger drives) where SSDs become too expensive for many users. Hybrids are also popular with laptops that only have one drive bay, letting you combine SSD speed with large storage capacity. As SSD capacities increase and prices drop we will likely see hybrid drives disappear – but for at least the next few years they can offer some worthwhile advantages.

HYBRID SSD BENCHMARKS

	SEAGATE LAPTOP SSHD	SEAGATE DESKTOP SSHD	WD BLACK2	STANDARD 2TB HARD DRIVE	SAMSUNG 850 EVO
AS-SSD - SEQUENTIAL READ/WRITE (MB/S)	85.39/ 112.07	155.93/ 134.90	386.01/ 139.98	143.26/ 122.51	503.1/ 489.77
AS-SSD - 4K READ/WRITE (MB/S)	0.67/3.95	0.77/2.68	24.82/ 78.32	1.22/5.69	35.03/ 104.66
AS-SSD - PROGRAM COPY (MB/S)	53.38	70.85	171.04	60.35	274.53
CRYSTALDISKMARK - SEQUENTIAL READ/WRITE (MB/S)	99.03/119.4	163.4/165.9	405.7/ 147.9	157.2/154.8	508.7/ 493.1
CRYSTALDISKMARK - 4K RANDOM READ/WRITE (MB/S)	0.518/4.63	0.61/1.42	27.25/ 76.02	0.98/2.31	40.19/119.0
WINDOWS 8.1 BOOT TIME (SECONDS)	42.4	41.3	34.5	123.7	30.1
COMPANY OF HEROES 2 LOAD TIME (SECONDS)	17.9	17.3	15.8	24.4	13.9
ADOBE PHOTOSHOP LOAD TIME (SECONDS)	5.8	5.9	3.4	19.7	2.8
COST PER GB (LOWER IS BETTER)	\$0.18	\$0.06	\$0.23	\$0.08	\$0.80



500GB, \$90; 1TB, \$120 | WWW.SEAGATE.COM

Seagate Laptop SSHDs

Perk up your laptop on a budget.

Seagate has dubbed its hybrid drives 'solid-state hard drives' (SSHDS) and these combine an 8GB SSD with either a 500GB or 1TB hard drive. These seem pitched at laptops, coming in 9.5mm, 7mm and 5mm versions to fit slim form-factor drive bays.

Seagate suggests the SSHD will give up a 4x speed improvement over a regular drive – but this is only true in certain circumstances. In testing, boot times were easily 4x as fast – although only after the drive had learned what to cache. It was still slower than a normal SSD, however. Programs also load faster, but transfer speeds are ultimately hamstrung by the hard-drive side and in our benchmarks were on par with normal drives.

The SSHD will make an aging laptop feel a lot zippier, but some aspects such as infrequently-used programs won't see much benefit. Since the caching is handled by a built-in

algorithm, rather than the OS, the drive will improve performance on PC, Mac and Linux platforms. It can even theoretically be used in a gaming console, like a PS3, to lower game load times.

Note that the full 1TB capacity is only available in the 9.5mm drive, with the thin 7mm and 5mm models providing 500GB of storage. Seagate's SSHDs are more expensive than a normal hard drive, and you can expect to roughly pay the same for the hybrid as the next size capacity hard drive. In the 1TB capacity, this equates to roughly a \$30 price premium, or \$20 for the 500GB model. Still, for those who need the space but still crave extra performance, this could be a solid laptop upgrade.

Verdict

Not an SSD replacement, but puts a little extra zip in your laptop without sacrificing capacity.





2TB, \$150; 4TB, \$240 | WWW.SEAGATE.COM

Seagate Desktop SSHDs

Bringing the hybrid drive to the 3.5-inch form factor.

Like its smaller cousin, the Seagate Desktop SSHD uses an 8GB SSD as a cache to improve performance. You can grab it in 4TB (as tested), 2TB and 1TB flavours, all of which offer a 7200rpm and SATA 6Gbps connection.

The hybrid desktop drive did not give quite as big a performance boost as the laptop model – likely because the hard drive side has a fairly decent read and write speed anyway. Still, boot times were halved and we saw noticeable improvements in app and game load times. It did take a few runs to get the drive to learn what data needed to be cached on the SSD, but overall the experience was quick and painless. Seagate's caching algorithm does all the work behind the scenes, so the drive is totally cross-platform with no setup needed and could even be used in

applications such as a NAS.

Ultimately the drive is better than a non-hybrid drive, but as with its smaller counterpart it isn't any faster for large file copies and, overall, can't compare to an SSD for pure performance. But then again, it's not trying too – instead it's giving oodles of storage with some very welcome speed boosts. In the 1TB capacity you pay around a \$20 price premium and \$30 for the 2TB. At the 4TB capacity we tested, the Desktop SSHD is on par in price compared to a standard 4TB hard drive, making it a great upgrade option for you.

Verdict

Easily worth the meagre price increase considering the boosted performance.



\$260 | WWW.WDC.COM

WD Black2

A different approach to the hybrid drive.

Unlike Seagate who uses a small SSD as a cache, with the Black2 Western Digital has sandwiched a 120GB SSD into a 9.5mm thick 2.5-inch hard drive. WD dubs this a 'dual drive', as the setup does not really operate as a hybrid and no automatic caching goes on behind the scenes.

Instead it's like two separate drives running through one SATA connection, with each showing up as a separate partition. This means you can install your OS and frequently-used programs onto the super-fast 120GB SSD and use the slower 1TB side for other storage. Importantly for laptop users, you can install the drive in a single drive bay. The Black2 gave SSD performance, albeit slower than what we saw with standalone drives. It is unquestionably faster than the caching-style

hybrid drives, but also more than twice as expensive, and around \$100 more than buying the SSD and hard drive separately. The drive does require some setup too – WD includes the software to clone your existing drive. Otherwise you can install your OS onto the SSD side, then use the software to unlock the 1TB portion.

Unlike other hybrids, the Black2 is designed for users who want to really push the performance of their existing laptops without sacrificing storage space or having to max out the credit card. It takes some extra setup and still commands a price premium, but is still almost half the cost of a 1TB SSD. ■

Verdict

A combined SSD and hard drive that can give you both performance and storage space.



Maximise your SSD's lifespan

Are you killing your solid-state drive with kindness? Darren Yates reveals the simple SSD secrets to a long and happy life.



Samsung's 840 TLC SSD can last up to 11 years on average usage.

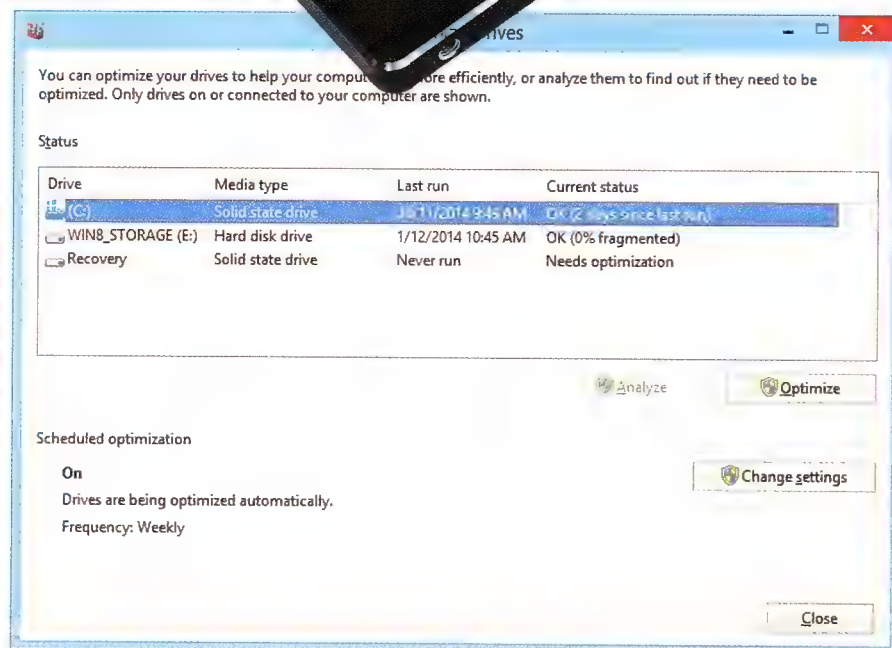
Solid-state drives (SSDs) really are a marvel of modern engineering – their speed and robustness are slowly, but surely, being matched by price as key virtues. But SSDs are also slowly, but surely, killing themselves each time you write data to them, so it's important to understand how they operate to maximise their working life and extend the time between replacements.

1 DON'T DEFRAG. EVER.

We were always told 'regularly defrag your hard drive to maintain faster access times'. On a mechanical drive, yes, that makes sense. But the thing that makes sense on a hard drive is the very thing that will send your SSD into an early grave. SSD seek times are so small that defragging is pointless anyway, even if it didn't kill your SSD. So don't do it. Ever. Or we'll come and take it off you!

2 GET YOUR TRIM ON.

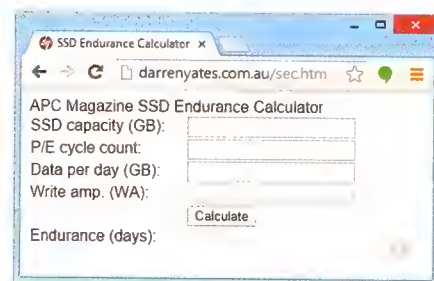
Garbage Collection (GC) and TRIM are often confused – GC occurs in every SSD, but TRIM is the technique for minimising the amount of data movement within the SSD, particularly when reclaiming abandoned blocks. Unlike a hard drive, you can't simply write over the top of an SSD cell – it must be erased first, then the data written. However, you also can't erase



Windows 8's new Optimize Drives utility automatically looks after SSDs.

around to help facilitate creating erasable blocks – without TRIM, the SSD also moves abandoned pages unnecessarily, which adds to wear and tear. Read this primer from LSI Corporation at tinyurl.com/qefh5bc.

While all new SSDs feature TRIM, you also need at least Windows 7, Mac OS X 10.7 (Lion) and Linux Kernel



Get a feel for how SSD longevity works with my free online calculator.

3 BULK UP WITH A HARD DRIVE

Given SSDs are fast but expensive per gigabyte compared with hard drives, it makes sense to use an SSD as your system drive and grab a hard drive for secondary bulk storage of videos, images and other files where speed isn't so much of an issue. With 1TB desktop drives selling for \$65 or

"Defragging is pointless anyway, even if it didn't kill your SSD. So don't do it. Ever. Or we'll come and take it off you!"

individual cells – SSD cells are grouped together first as pages, then as blocks. You can write to a page, but can only erase a block. SSDs move data

2.6.33 to gain OS-side TRIM support. Linux distros don't always enable TRIM (say, Ubuntu pre-14.04), so check before you dive in.

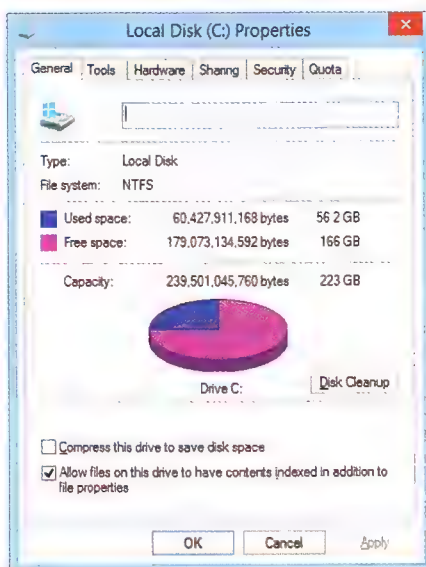
less, you may be able to get away with just a 120/128GB SSD for a system drive if you're not into gaming. But as we'll discuss shortly, there are good reasons for going to a larger 240/256GB drive if your budget allows.

4 DON'T OVERLOAD YOUR SSD

More importantly, make sure you don't fill your SSD to the brim. SSDs need some spare space for internal housekeeping as well as backup cells for those that die. That's why I prefer 120 or 240GB SSDs as opposed to 128 or 256GB drives. Internally, they're the same capacity, respectively – the difference is the apparently smaller capacity drives hive off the extra space as 'spare', just like having a spare wheel in your car. In general, it's recommended you shouldn't exceed 75% of your SSD's capacity in order to help to maintain performance levels – go beyond that and the drive performance dips.

5 GO LARGE ON YOUR SSD

There are three main SSD cell types you can buy – single-level (SLC), multi-level (MLC) and triple-level (TLC) and they refer to the number of bits stored per cell. Bottom line, SLCs are good for up to one million program/erase cycles, MLCs up to 10,000 and TLC somewhere around the 1,000 mark. Beyond those respective levels,



Go for a larger-capacity SSD and don't fill it beyond 75% of its capacity.

the cells start to die off and forget/lose your data.

Naturally, SLC SSDs are more expensive than TLC types, but rather than fuss with cell type, the simple solution is to just buy a larger-capacity SSD. We explain it below, but the 'TL;DR' version is this – the limit of SSD longevity is the number of storage cells multiplied by the number of program/erase cycles per cell. In that context, having more cells (a larger-capacity SSD) has the same effect as having cells with more P/E cycles (MLC or SLC vs TLC). It's thanks to a technique called 'wear levelling', which aims to ensure all cells get equal usage. So in theory at least, a 240GB SSD should automatically last twice as long as its 120GB counterpart and twice as long again as the 60GB version with exactly the same usage pattern.

6 CRANK UP THE RAM

But arguably the most important tip is there's no point using an SSD to paper over cracks appearing elsewhere in your system – and primarily, we're talking about insufficient system RAM. Windows' pagefile system fires up and trashes the SSD every time you run out of RAM, so using an SSD when you have RAM issues is just plain dopey.

How long does it take to kill an SSD?

A damn long time, as it turns out. Take Samsung's 128GB-capacity '840' SSD with its 1000-cycle rated TLC flash as an example and let's say you write 10GB of data per day (the usual 'average user' figure). That 10GB doesn't include other data the drive itself writes during normal functions such as garbage collection – the extra referred to as the 'write amplification factor' (WAF). Ideally, you'd like a WAF of 1x, meaning the data you save is the only data the SSD writes. If it's 5x, the SSD writes 5MB for every 1MB of data you want stored (2-3x is considered 'normal').

Back to our 10GB per day, let's say you have a 3x WAF, meaning the drive writes 30GB per day. With a 128GB capacity and 1,000 write cycles, the formula is:

$$\text{Lifespan (in days)} = \left(\frac{\text{drive capacity in GB} \times \text{write-erase cycles}}{\text{data written per day in GB} \times \text{WAF}} \right)$$

$$= (128 \times 1000) / (10 \times 3) = 4,267 \text{ days or 11.7 years.}$$

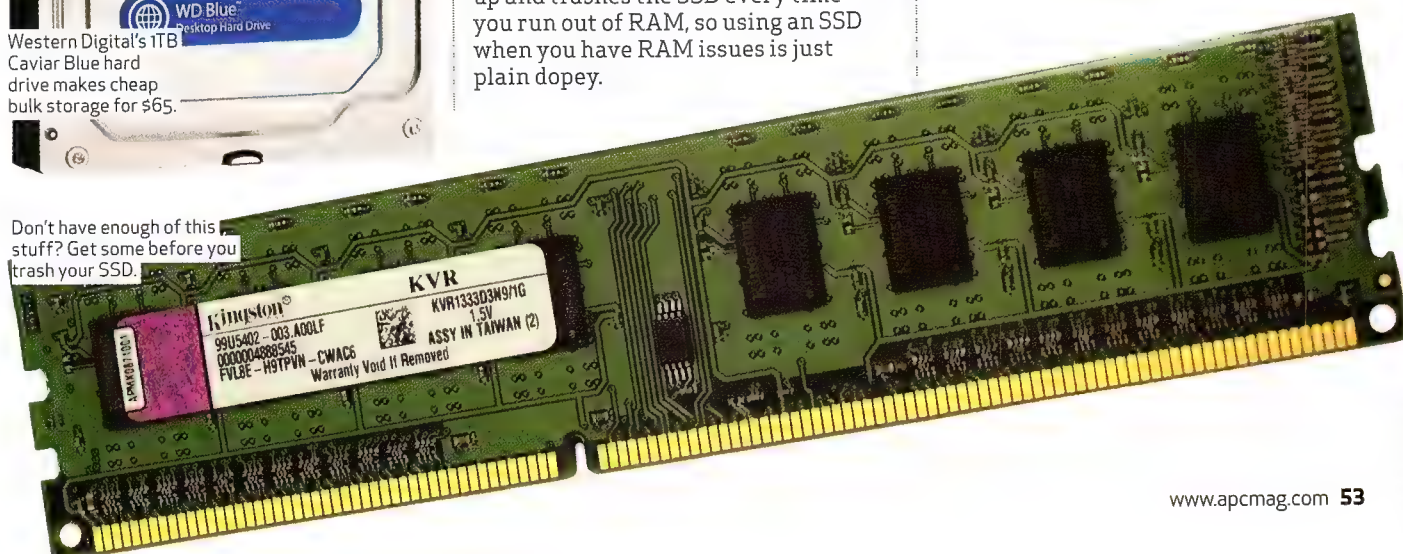
That's a damn long time and I wouldn't trust a hard drive to get near that. But it's also an 'average use' lifespan, so you'll have to adjust it for your own usage patterns. To help, I've put this all into a simple SSD Endurance Calculator at darrenyates.com.au/sec.htm.

DDR3/4 RAM is down to \$10-12 per gigabyte, so get your system complement up to 8GB at the very least before you start mucking around with an SSD (personally, I'd go 16GB but that's just me). Even if you keep the same CPU, get the RAM and SSD setup right and you won't recognise yourself! ■



Western Digital's 1TB Caviar Blue hard drive makes cheap bulk storage for \$65.

Don't have enough of this stuff? Get some before you trash your SSD.



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Bulletproof backup on a budget

Craig Simms tests seven new dual-bay NAS boxes, which can give you redundant backup capabilities for less.



With hard drives ever-increasing in capacity, the need for the big, four-bay plus NAS boxes of old is reducing for many. Why swallow the cost of a four-drive RAID 5 unit when RAID 1 will do?

But let's back that truck up for those new to network attached storage, or NAS. At its most simple, a NAS device is a small fileserver that sits on your network, providing storage to multiple people at once, with a level of protection against hard drive failure.

This means RAID — or Redundant Array of Inexpensive Disks. Your options are limited with only two bays, and in most circumstances this means RAID 1, or mirroring. Pop in two hard drives, and everything copied to one drive is automatically copied to the second. If one fails, the second takes over and you replace the dead one as quickly as possible. This does mean you only get half the usable storage you pay

"...you could get a 24 bay, dual 10-gigabit Ethernet unit if, say, you owned the world's biggest collection of Linux ISOs."

for, but it's worth the peace of mind.

If you want the capacity of both disks to be usable, you can usually set them up as individual disks or spanned disks (once one drive fills up, the NAS starts writing to the second, but presents these as a single volume). This is known as "just a bunch of disks", or JBOD. Lose a disk here, and you'll only lose the data on that disk.

There's also RAID 0, also known as striping, but it's a considerable risk. The technique spreads data equally across both disks, and is designed to increase data throughput rather than offer any redundancy. As such, if one disk dies, you lose all your data.

BUYING HARD DRIVES

Many NAS come barebones — that is, without hard drives included. While you can buy ordinary hard drives, we'd suggest you stick to the NAS specific variants, as they're optimised for 24/7 use and the kind of access patterns seen on NAS. This means sticking to either Western Digital's Red drives, or Seagate's NAS series.

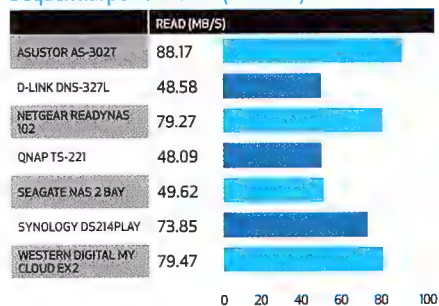
WHAT SHOULD I BUY?

The dual bay NAS market varies heavily in specs, from lower end ARM chips all the way to quad core Intel chips. You'll need to keep an eye on RAM as well. As a general guide, we'd say try to at least snag a dual core Atom box with 1GB RAM, but if you've got modest needs, the 512MB ARM boxes will mostly fill the role just fine.

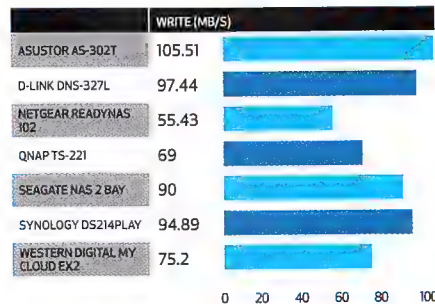
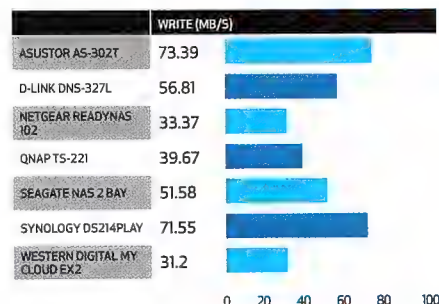
Of course it's not just about hardware. Most NAS these days come with apps to extend their functionality. While many include things like web and SQL servers from the get go, depending on the vendor you can get photo browsers, video and audio streamers, cloud storage integration, download tools, even old console emulators. Heck, some high end NAS can even run Minecraft servers. We've listed available apps in the specs box for each review unless there's simply

LABS BENCHMARK RESULTS

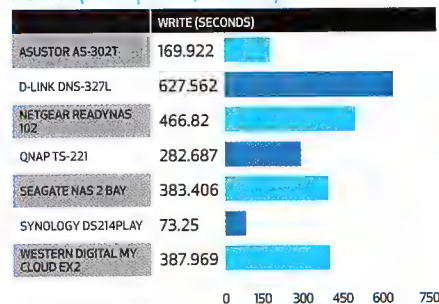
Sequential performance (2GB file)



Simultaneous (2GB file, dual stream)



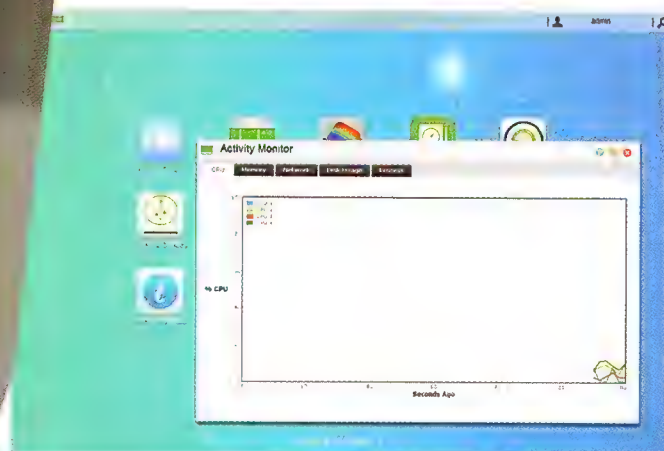
FC Test ("Win" profile, seconds)





A strong showing from Asustor.

CRITICAL SPECS: Intel Atom 1.6GHz, 1GB RAM, Gigabit Ethernet, 2x USB 3.0, 2x USB 2.0, HDMI, headphone jack.



\$389 DISKLESS | WWW.ASUSTOR.COM/APPS?LAN=EN&TYPE=&MODEL=2XX,3XX | WWW.ASUSTOR.COM

Asustor AS-302T

Despite the name, Asustor isn't an anime robot from the 80s.

too many, in which case we've provided a URL. We recommend checking these out before making a purchase – what's out there may just change your mind.

WANT TO GO BIGGER?

Many of the vendors on test here have more powerful NAS boxes available, right up to quad core units with 2GB of RAM. Generally this will mean not only better transfer performance, but it should be able to handle multiple transfers better, run NAS apps more effectively, and rebuild arrays faster after you've had a disk failure. The latter is important – the less time you have with the chance of losing another drive, the better.

Of course these things can go as deep as your wallet and lust for data transfer allows; you could get a 24 bay, dual 10 gigabit Ethernet unit if, say, you owned the world's biggest collection of Linux ISOs. Many NAS bays also support 2.5-inch drives, meaning you could kit them out with SSDs if you're fortunate enough to be able to run such a beast. Ultimately a NAS purchase should be customised around your needs.

HOW WE TESTED

Three tests were used: a 2GB file was sent to and from the NAS; the same 2GB file was sent as two streams simultaneously to and from the NAS; and FC Test was used to simulate copying a series of smaller files, to represent a more common backup task. Since each of these NAS are vastly different in specs, the benchmarks shouldn't be used so much for comparison as an indication of each unit's capability. Each NAS was tested with a pair of 4TB Western Digital Red Drive Pros in RAID 1.

Rather than just being a standard NAS, Asustor's AS-302T integrates an HDMI port and headphone jack. Install the Asustor Portal app, set the appropriate resolution, plug in a mouse and keyboard, hook the NAS up to your TV and you get an easy-to-use interface that runs apps like Chrome and XBMC. While you can buy a remote separately, its functions are quite limited.

Asustor has a massive number of apps for its NAS, including the Snes9x emulator, Sick Beard, SABnzbd and Couchpotato. The OS itself ships in a slimmed down state, with services like the iTunes and UPnP AV servers downloadable separately. It does do all the standard things out of the box though, with Rsync, FTP, USB and Amazon S3 backup capability; iSCSI, SSH, WebDAV and AD support; FTP, SMB, AFP and NFS file access.

The EZ-Router app will

talk with UPnP routers to ensure internet access to your NAS should you require it, while the support for multiple DDNS services should help this along. Multiple apps are available for you to interact with your NAS through your mobile phone, from file to NAS management.

The front of the unit features a USB 3.0 port attached to a customisable one-touch backup button, while the rear has another USB 3.0 port, the aforementioned HDMI and headphone jack, and two USB 2.0 ports. The USB ports support file sharing, printers, WiFi/bluetooth adapters, UPS management and optical drives.

If you've got the cash, this NAS makes a great choice.

Verdict

Asustor puts in an amazingly strong showing for its price bracket. Recommended.



CRITICAL SPECS:

Marvell 1.2GHz, 512MB
RAM, Gigabit Ethernet,
USB 3.0 port



\$149 DISKLESS | AJAXPLORER, AMULE, AUDIO STREAMER, BLOG, JOOMLA, PHOTO CENTER, PHPBB, PHPMYADMIN, TRANSMISSION, SQUEEZECENTER. | WWW.DLINK.COM.AU

D-Link DNS-327L

This entry level NAS needs a little more work.

Coming in all-white, D-Link's NAS first requires you to attach handles to your drives before inserting them. It was also the loudest of all the NAS on test, with disk access magnified and obvious.

The interface feels very old compared to its competitors, with a fresh coat of paint required. Still, it's serviceable, and the help panel on the right hand side is welcome. Weirdly unlike every other NAS, there's no online check for firmware updates, or iSCSI support.

It includes the standard capabilities – DDNS, UPnP streaming, Time Machine and iTunes support, access to your files over FTP, SMB, AFP and NFS. There's an FTP/HTTP download manager, a scheduled torrent downloader, and it will integrate with Amazon S3 and Google Drive.

By default D-Link ships with a file manager, photo browser, music player and an app for security cameras. Like the WD My Cloud EX2,

additional apps are fairly limited, but cover the basics. One, simply called "Blog", is actually a Wordpress install.

There's only a single USB 3.0 port, with D-Link offering both USB storage sharing and printer compatibility.

Performance was a little odd. While the read speeds didn't reach the heights of other NAS, write speeds managed to be significantly faster than the likes of WD and Netgear. At the same price though, the Netgear has more features, a more robust construction, is quieter, and has better small file write performance. WD also puts in a stronger showing once you take drive bundling into account – so there are better budget options about.

Verdict

The DNS-327L may be affordable, but it takes too many shortcuts compared to its competitors.



CRITICAL SPECS:

Marvell Armada
1.2GHz, 512MB RAM,
Gigabit Ethernet,
USB 2.0, 2x USB 3.0,
eSATA



\$149 DISKLESS | APPS.READYNAS.COM | WWW.NETGEAR.COM

Netgear ReadyNAS 102

Are you ready for NAS?

Netgear presents us with a simpler, perhaps slightly outdated interface for its ReadyNAS 102. It still very much gets the job done, and is by and large easy to navigate.

The usual suspects are all here in terms of protocol support and features: AFP, NFS, SMB, FTP, SSH, iSCSI, UPnP streaming, iTunes and Time Machine support. Cloud backup is available using Netgear's own ReadyNAS vault service, as well as Dropbox. Local backup can be performed over attached external storage, while the unit will also support FTP, NFS or Rsync backup.

Online access is available through web and app by setting up a ReadyCloud account, although if you want to reach the NAS admin page you'll need to be on the local network.

The longevity of the ReadyNAS brand has meant a reasonable collection of apps have appeared over time, including Sickbeard,

Couchpotato and SABNZBD, although it's long been outstripped by the likes of Asustor, Synology and QNAP. Vexingly, you also cannot do anything else in the ReadyNAS UI while installing an app on the system.

While not the most featured NAS around, the fact remains the ReadyNAS 102 is a good performer at a low price. If you've already got hard drives to throw in, it makes a good, cheap choice – but if you're looking to buy new, you might want to consider the WD My Cloud EX instead with bundled hard drives.

Verdict

A solid, basic offering from Netgear. Expansion in capability would give it an extra boost.



CRITICAL SPECS:
Marvell 2GHz, 1GB
RAM, Gigabit
Ethernet, 2x USB
3.0, USB 2.0, 2x
eSATA.



\$379 DISKLESS | WWW.QNAP.COM/1/EN/APP_CENTER/ |
WWW.QNAP.COM

QNAP TS-221

Thorough features, but needs more performance.

The QNAP TS-221 provides a USB 2.0 port on the front with a configurable one-touch copy button, while on the back are two USB 3.0 ports and just as many eSATA.

Firmware can be installed by browsing to start.qnap.com and signing up for a QNAPCloud account, which also gets you a DDNS subdomain. Unfortunately the process ultimately couldn't find our NAS, so we installed manually through the QFinder app.

QNAP's firmware is always impressive, complete with a full desktop, drag and drop and a neat little stats dashboard. It supports the standard options — DDNS, iSCSI, FTP, SMB, DLNA, iTunes, Time Machine, NFS, AFP — but supplements this with SSH, TFTP/SFTP, RADIUS, active directory support and more. Backup options cover Amazon S3, ElephantDrive, Symform, Rsync, and USB drive. USB ports can also be used for Wi-Fi, printers, and UPS.

On the media side, the QNAP offers both regular and TwonkyMedia DLNA, and can transcode videos for streaming to mobile devices, to a resolution of your choosing.

There's an army of apps, and it's worth checking out the link in the specs box to see exactly what's available. QNAP also provides mobile apps for almost any function you can think of, although Android gets a greater range than iOS.

Performance is confusing — while you're paying for a range of features and great interface, the TS-221 lagged competitors significantly in our 2GB transfer tests, only making up ground in the small file transfer test. For only \$10 more, consider the Asustor AS-302T.

Verdict

Fantastic features from QNAP, but we'd want something higher performing for the price.



CRITICAL SPECS:
ARM 1.2GHz, 512MB
RAM, Gigabit
Ethernet, 2x USB 3.0



\$299 DISKLESS, \$429 2TB, \$499 4TB, \$699 8TB, \$1099 10TB |
ANTIVIRUS, BITTORRENT SYNC, ELEPHANTDRIVE, OWNCLLOUD,
SURVEILLANCE MANAGER, WORDPRESS | WWW.SEAGATE.COM

Seagate NAS (2-Bay)

The big black box.

Seagate's interface is modern, minimal and slick. It makes for something that's user friendly, incredibly readable and mostly easy to use.

Not so user friendly is getting you to enter the NAS MAC address when you turn it on for the first time. Apps are also very limited, although as Seagate has seen fit to divide available apps into categories, this suggests it expects to eventually expand the selection in the future.

Internet access is possible with a mynas.seagate.com URL. Refreshingly, you don't need to sign up to any online account — just choose your URL in the NAS interface and you're away. This is complemented with an app called Sdrive, available for OS X, Windows, iOS and Android, to access your files wherever you may be. Weirdly, you have to activate the NAS through either the OS X or Windows app first, or you'll be limited to access on the local

network. A downloading app is available for torrents and URL-based downloads, but is quite simple and doesn't support scheduling.

It does support SMB, AFP, NFS, FTP, WebDAV, iSCSI, Time Machine backups, iTunes and DLNA streaming, and you can access the box over SSH. Backup is available to another Seagate NAS, through Rsync, Amazon S3, Box, FTP, SMB, NFS, WebDAV or USB hard drive. The USB port can also be used for a printer if you wish to share one on either of the two USB 3.0 ports.

It outperformed Western Digital on the write, while vice versa was true on the reads, pulling near equal on the small file transfer test.

Verdict

While more polish would be good, we can see where Seagate is heading. A decent effort.



CRITICAL SPECS: Intel Atom 1.6GHz, 1GB RAM, Gigabit Ethernet, USB 2.0, 2x USB 3.0, SD card, eSATA



\$419 DISKLESS | WWW.SYNOLOGY.COM/EN-US/DSM/APP_PACKAGES/ALL_APP | WWW.SYNOLOGY.COM

Synology DS214play

The always polished Synology delivers again.

With a full-blown desktop, app menu, and widgets for at-a-glance status updates, Synology's interface is both slick and powerful, with more features than is possible to fit in this review. If you feel the need to expand capabilities even further, there's a plethora of apps available that you can peruse at the URL in the specs link above.

The "play" indicates files containing H.264, MP4 Part 2, MPEG 2, and VC-1 codecs can be transcoded for multiple devices (like Chromecast, AppleTV, iOS, Android and so on) up to 1080p in resolution. A large variety of other codecs are also covered, although will only transcode up to 720p.

The unit can backup to Amazon S3, Azure, HiCloud, SFR Stockage, external USB, another Synology NAS or Rsync server. Its Download Station allows for scheduled Bittorrent, FTP, HTTP, NZB and eMule downloads, while the Cloud Sync app allows

for integration with Google Drive, Dropbox, OneDrive, Box and more.

A Security Advisor app advises on weaknesses, while EZ-Internet ensures access from the internet if required. Combined with a MyDS account, you should be able to access anything pretty much anywhere.

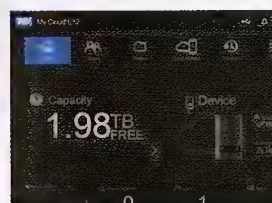
The unit is coated with a rubberised plastic that is high grip, and slightly unpleasant to the touch. Annoyingly the front cover pops off rather than being hinged, but as a positive the drive sleds are toolless. The front has a USB 2.0 port and SD card slot, while the back has two USB 3.0 ports and eSATA. USB support is extensive, covering storage, Wi-Fi, Bluetooth, printers, and even DTV dongles.

Verdict

You pay for the Synology name and features, but it's a polished, highly featured experience.



CRITICAL SPECS: 1.2GHz, 512MB RAM, Gigabit Ethernet, 2x USB 3.0 ports



\$299 DISKLESS, \$399 4TB, \$599 6TB, \$699 8TB | HTTP/FTP/TORRENT DOWNLOAD, AMULE, DROPBOX, DVBLINK, GIT, ICECAST, JOOMLA, NZBGET, PHPBB, PHPMYADMIN, SQUEEZECENTER, TRANSMISSION, WORDPRESS. | WWW.WDC.COM

Western Digital My Cloud EX2

Sunshine in the clouds.

The My Cloud EX2 has a clear, well thought out interface. Even user management is easy, with the initial setup asking you to "invite" others to use your "personal cloud" through a username and email address, immediately after you set up your own WD My Cloud account.

This account can be used with the WD My Photos app (which views photos on the NAS, or backs them up from your mobile) and WD My Cloud app (file access, including uploading new files), to access your NAS from anywhere. Daftly, you can't view the web interface or your files remotely through WD's My Cloud site itself – after login it just gives you links for the aforementioned apps.

iTunes, DLNA and Time Machine support are baked in, there's iSCSI and ISO mounting support, and you can access your folder shares over SMB, FTP, WebDAV, NFS or straight up

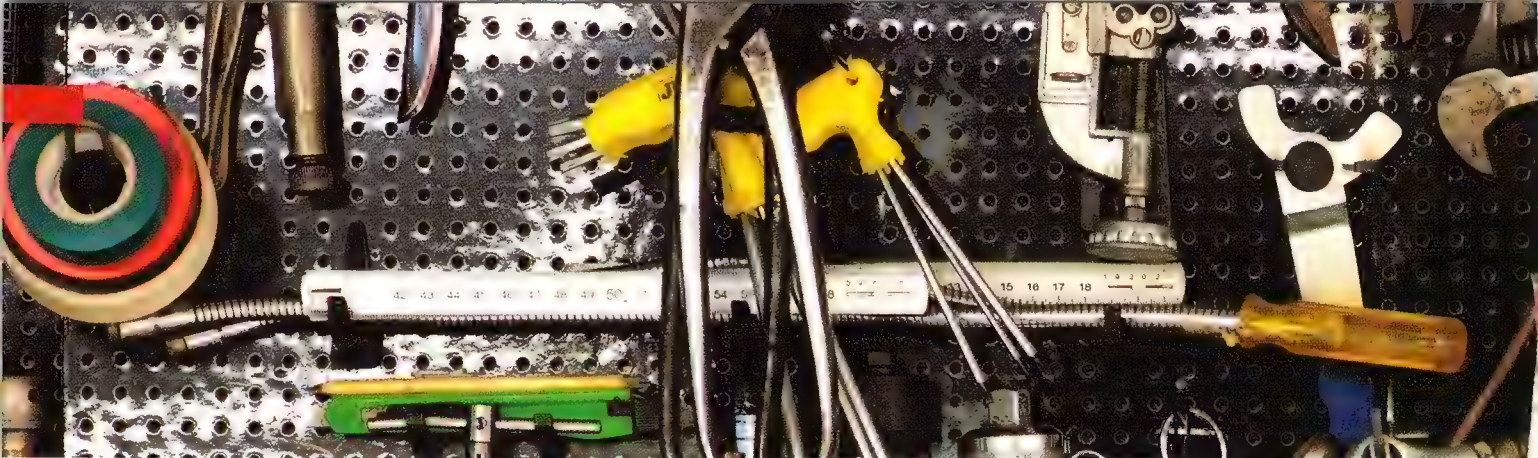
web interface. Backup is available to ElephantDrive, Amazon S3 and other My Cloud EX2 units; to and from USB drives; and from digital cameras. USB drives can be shared.

Annoyingly there's no power button, but you do get two USB 3.0 ports for your money. Performance is decent for the price – but for units without disks, the ReadyNAS 102's significantly cheaper entry point is hard to ignore. Where WD shines is its bundled units, with the included WD Red drives making the My Cloud EX2 a much more compelling choice. ■

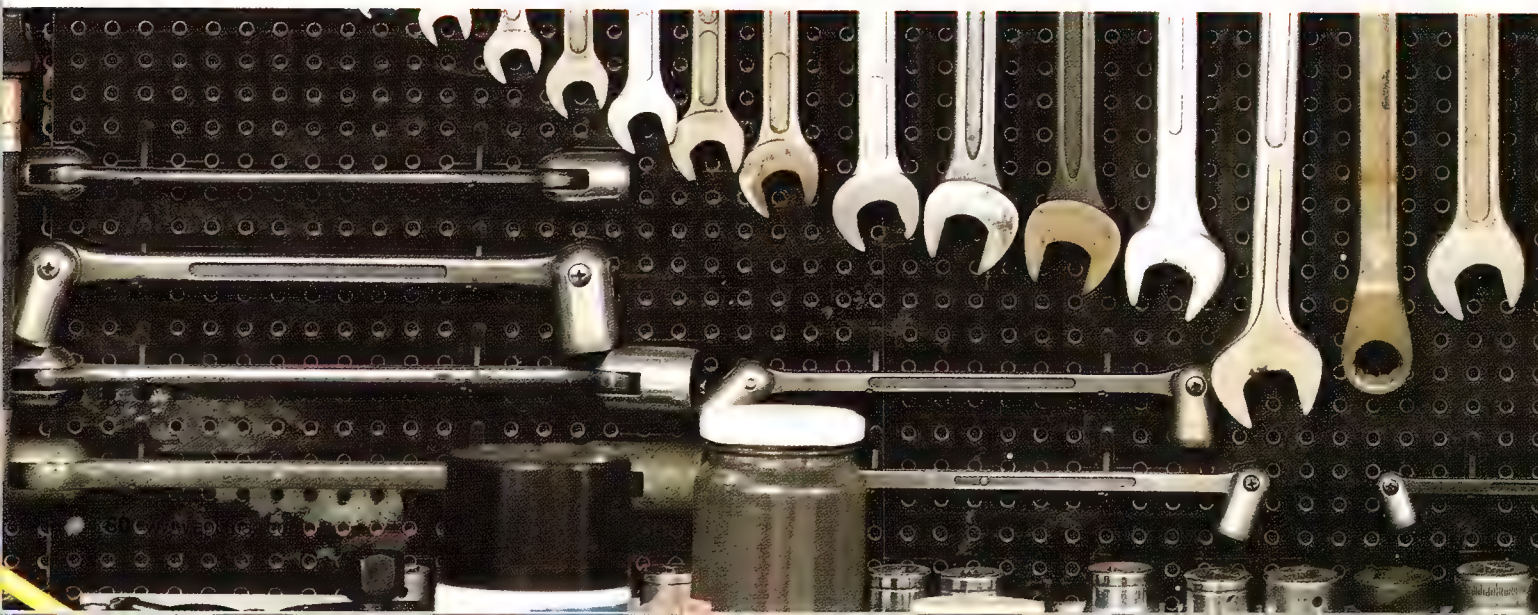
Verdict

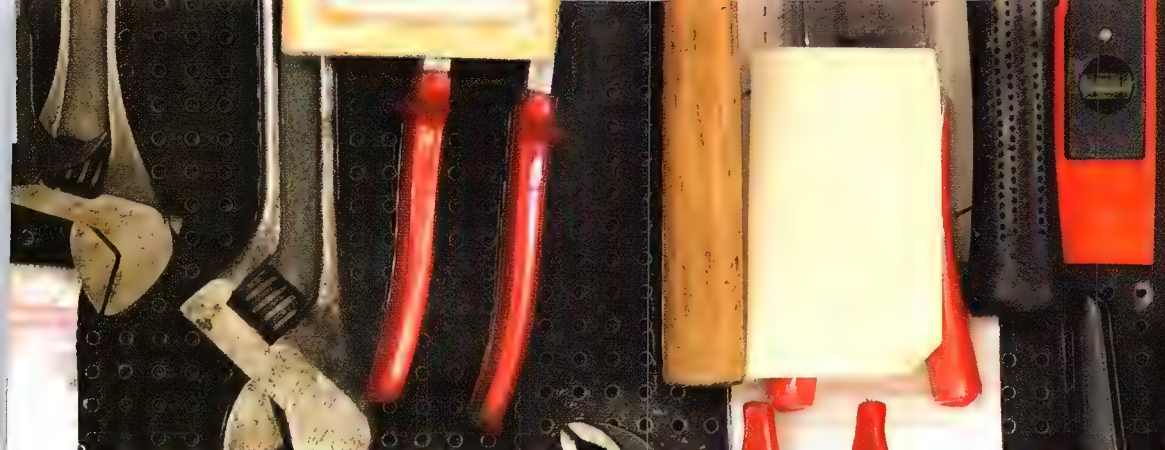
WD offers performance for a good price, giving enough features for the entry level to moderate user.





HOW TO BE A TECH GURU





THE ANCIENT ART OF SOLVING ANY COMPUTER PROBLEM

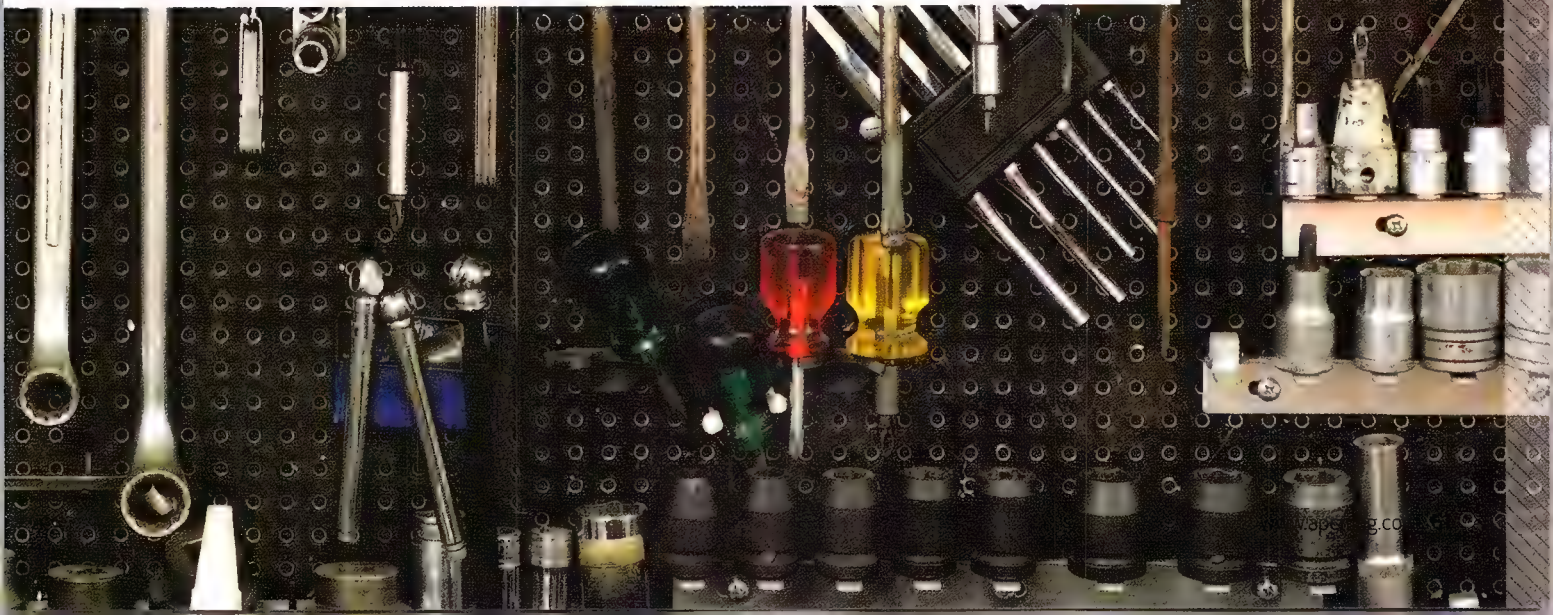
Expert is a relative term – by which I mean it's a term that our relatives use. "Ask Luis, he's the computer expert," my mother-in-law will say, to anyone who will listen. I've spent more than twenty years fixing other people's problems, so I'm used to being called an expert, but the reality is that every family has its own expert.

To qualify, you just need to be the youngest adult in the room that owns a PC. Sooner or later, someone will mention their laptop is broken or iTunes keeps crashing, and you'll feel guilty into taking a look. Whether or not you ultimately manage to fix it makes no difference; you'll still be the expert. After all, you've just spent a frustrating Sunday afternoon downloading drivers or booting in and out of Safe Mode, so you must know what you're doing.

But this is no way to live. Nobody wants to be that sort of expert; it's not effective and the hourly rate is terrible. There are people who actually enjoy

pointlessly fiddling with computers, but you aren't one of those people and neither am I. What we both want is to spend the minimum time fixing computers, and the maximum time actually using them. It doesn't matter whether you are fixing your own computer, doing a favour for a relative or even fixing computers professionally; the goal is always to find the quickest, simplest fix that works.

That's the difference between an expert and a guru. A guru can listen to a long, rambling list of unrelated symptoms and decide which ones need fixing and which ones don't. A guru knows how to Google quickly for the right answer. A guru understands when to spend time on a problem and when to spend money. Most importantly, a guru doesn't spend his spare time swapping RAM or reinstalling Windows – he spends it playing PC games. A guru enjoys all of the kudos of being an expert, with none of the hassle – and I am going to teach you how to be one. ▶





"There is no 'weird old trick' that Microsoft doesn't want you to know about speeding up your PC"

Let's start with your own PCs. You need two: a desktop and a laptop. The laptop should be cheap and the desktop should be mid-range. You may be tempted to combine the two and get an expensive laptop: don't. The desktop is for games, which means you need a large monitor, a respectable graphics card and CPU, and good speakers. If you try to do this on a laptop, you will end up paying far more for the same performance — and using an external monitor, speakers and mouse on a laptop, just turns your laptop into an unwieldy desktop. You also want to be able to upgrade the graphics card once during the working life of a games PC, and this is all but impossible to do with a laptop.

Once you free your laptop from gaming duties, you can get by with a \$800 model that will do all the workaday tasks, like sofa surfing, email, word processing and spreadsheets. This ring-fences the activity most likely to cause computer problems (that is, gaming) from all the other things you need a computer for, and it means that whichever one breaks, you've got another one to use for Googling solutions.

Put the desktop PC on the table, not the floor and turn the

case so that it faces sideways. If you have it with the front facing towards you, like most people do, the rear becomes a stagnant tangle of cables that never gets dusted. Some of that dust will get pulled back into the case and coat your motherboard, which means the poor clearance interferes with case ventilation.

Back up both of your PCs once a month without fail. These should be complete clones of the entire hard disk using Acronis True Image (acronis.com) onto an external USB drive that is at least as large as the internal drive in your PC. Use a different backup drive for each PC. Don't keep your documents on the internal hard disks at all. Put them in cloud storage, like Microsoft OneDrive, Dropbox or Google Drive. This entirely saves you from the responsibility of backing up those small, important, frequently changing files, which is most of what you need a backup for in the first place. Those clone drives are just there for disaster recovery.

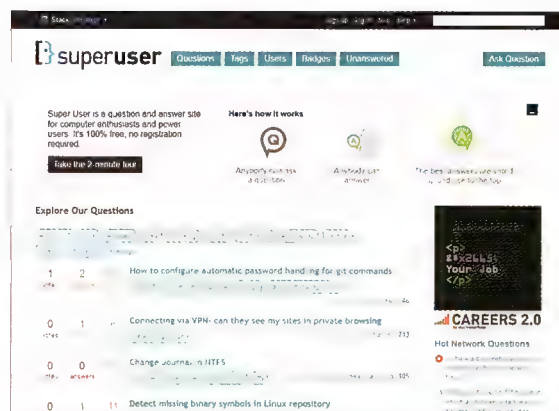
SURPRISING ADVICE

If you're giving advice to others, then you should tell them, "don't build your own computer." Ten years ago this was a good way to

learn how a PC was put together, but from a support perspective you're just making things hard for yourself. It's also much harder to claim on the warranty when something doesn't work, because all the manufacturers will blame each other for any incompatibility.

Don't ever reformat and reinstall Windows. This is the last apple at the bottom of the troubleshooting barrel. It takes ages, the PC is never quite the same afterwards and it doesn't fix the problem. If you are desperate enough to reinstall Windows, you are desperate enough to get a new PC — which will fix the problem. Don't update your drivers, either. I know that this is the first item on just about every troubleshooting

The answers at StackExchange can usually be trusted



How to Google

Not everything on the internet is true

'Google-fu' is a martial art that gets better with practice, but here are some quick tips to help you sharpen your searches.

Don't Google the question, Google the answer. "watch dogs crashes randomly" will give you dozens of forum posts, but the answers will mostly be a mix of bland advice, requests for detailed crash logs, and suggestions of things to try. Instead, Google "watch dogs patch notes" and you can quickly skim the list of

bug fixes to see if any of them addresses your problem.

Ignore search results that are YouTube videos. A video is much harder to skim and the comments section offers very poor feedback.

Avoid slideshows too. "8 tips for getting Watch_Dogs running smoothly" is just a way for commercial sites to generate page views. Six of those tips will be generic things like "upgrade your RAM" and "install the latest drivers" and the other two won't apply to you.

Use the wisdom of the crowds. Don't look for a single forum post with a definitive "right" answer —

skim all the sites on the first page or two of the search results and look for common patterns. If the same fix is confirmed on several different sites, it's much more likely to be reliable.

Know which sites to trust. Search results from stackexchange.com are particularly valuable because they use a rigorous voting system for the answers. Game developer forums and answers.microsoft.com are the next tier down. Sites like answers.yahoo.com and answers.com are garbage.

flowchart ever, but after 20 years, I have come to the conclusion that this is a stalling tactic dreamt up by customer support hotlines to get you to go away for a few hours. Unless you know of a specific bug in your current driver release that you are personally experiencing and the release notes for the new version explicitly mention that this bug has been fixed, all you are doing is adding one more variable into the mix. New drivers are just as likely to introduce new bugs as fix old ones, so higher version numbers aren't necessarily better.

With this foundation laid, your PCs will definitely never ever break or crash. When they inevitably do anyway, you will find that all computer problems fall into one of five categories.

1 SPONTANEOUS BREAKAGE

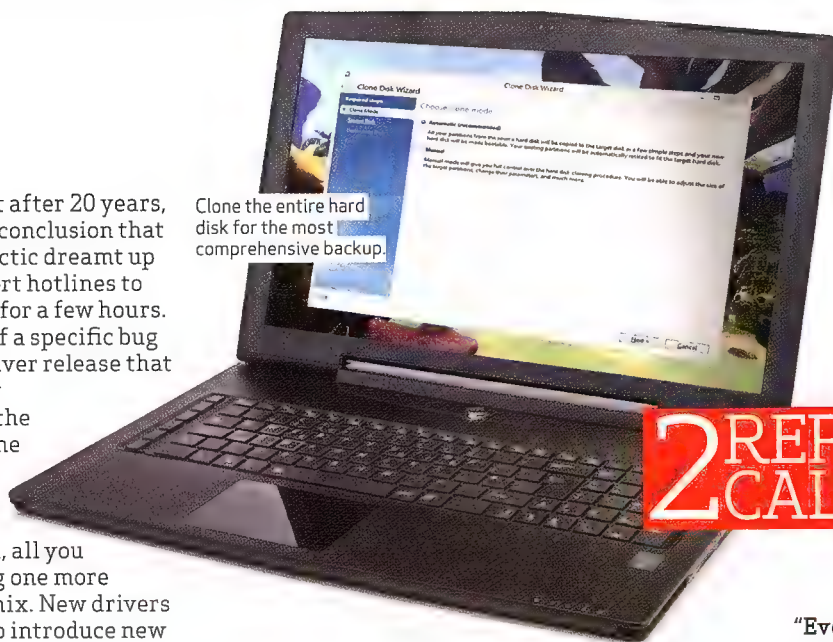
"It was working fine until I dropped it"

The first category is for computers that abruptly transition from working to not. This could be refusing to boot up at all, or it could be that you can't connect to Steam, or maybe *Watch Dogs* has scrambled textures. It doesn't matter what stopped working, the important part is that it stopped suddenly.

Spontaneous Breakage is the easiest problem to diagnose; it occurs because something changed. Either a hardware component failed or you added something that was incompatible. Identify the last time you can say that the PC was working, and the problem must lie with something that changed since then. Uninstall any new software or restore your PC back to the previous full backup and see if the problem goes away. Then repeat any Windows updates and reinstall programs one by one until it returns, just to make sure.

If you haven't added anything to the PC recently and it broke anyway, then you can be sure that a hardware component has failed. If the PC won't boot, you can usually tell which component is dead by how far into the boot sequence the PC gets. But if you aren't sure, you

Clone the entire hard disk for the most comprehensive backup.



2 REPRODUCIBLE CALAMITY

should just replace the RAM, PSU, graphics card and hard disk — in that order. This is so that you check the easiest components first, not the most likely. Your assessment of likelihood is probably wrong, and you'll save time in the long run if you get into the habit of checking the easy things first. You might think that a game with messed-up textures can only be caused by a faulty graphics card, but RAM and PSU faults can both cause this as well, and they are both much cheaper to replace.

Inevitably, you'll end up replacing some perfectly good components unnecessarily this way. So you should always buy upgrades, rather than exact replacements. That way, all your wrong guesses are at least upgrading your PC along the way — and you can hang on to the spare parts.

No one ever made their PC worse by adding more RAM.

"Every time I try, it just crashes"

If you can reliably crash an application or generate one of those error messages that end-users were clearly never meant to see, then congrats! You have found a bug.

Finding bugs is a well-paid job for some people, so if you enjoyed finding it, you should consider a career in software Quality Assurance — but bear in mind you have only found one so far, so don't get too carried away. There is generally nothing you can do about a bug except report it to the developers (if they give you an easy way to do this, of course) and hope and/or pray that it gets fixed in the next version.

In reality, this is rather like voting in a general election: it's your duty to do it, but it doesn't actually make any difference. In the meantime, you'll just have to work around the bug, but at least you don't need to waste any more time looking for a solution. After all, most of the developers won't, either. (That's satire, that is.)

The screenshot shows the Crucial website interface. At the top, there's a navigation bar with links for 'store', 'memory', 'storage', 'community', and 'support'. Below this, there are sections for 'Memory' and 'Solid State Drives', each featuring product images and links to 'shop now', 'learn more', and 'support'. A prominent 'Crucial Advisor' tool is highlighted, titled 'Two ways to find compatible upgrades'. It offers two methods: using the 'Crucial Advisor™ tool' if you know your system's specs, or using the 'Crucial System Scanner' if you don't. Both methods involve downloading a scanner tool to analyze hardware and provide a list of compatible upgrades. A sidebar on the right says 'GFT HFID'. At the bottom, there are more product images for various memory modules and SSDs.



Avoiding the experts

How to avoid being fobbed off and brow-beaten by the well-meaning clueless.

The guy in the shop is not a computer expert; he's just someone with good interpersonal skills who knows his way around the basics. If your mum wants to set up her Gmail account in Windows Live Mail, he can help. If you come to him with your weird Blue Screen error, you'll be given some misleading flannel and then steered towards a sale.

The woman in the call centre is not a computer expert. She's working from a troubleshooting flowchart of simple solutions to the most common problems. Her goal is to get rid of you as quickly as possible, so she can keep

her call stats up. These are not bad people, they just aren't the droids you're looking for.

The truth is that there aren't really any experts. There are just people who have come across the same problem as you, and people who haven't and are guessing loudly. To be a Tech Guru you need to start filtering out this noise. The only reason for visiting a computer shop is to see if you like the keyboard on a specific laptop. The only reason for ringing a customer support line is for billing enquiries and refunds, or for problems with your

broadband connection. Everything else you will fix for yourself, armed only with the internet.

Online is actually the only place you are likely to come across honest answers. In the real world the people who know them are tucked away doing well-paid jobs far away from grubby customers. But online you can get their help for free. Don't waste time soliciting it directly; just skim the forums for similar questions and triangulate the suggestions from the most well-informed replies. If your problem is common enough, someone else will already have asked.

3 CREEPING BADNESS

"It's just getting worse."

'Badness' nearly always means that your PC is getting slower. And normally, the solution is just to put up with it. I know that's not what the internet tells you. But like promises of youthful skin and powerful erections, the solutions offered on the internet to speed up your PC are all scams for the feeble-minded. There is no 'weird old trick' that Microsoft doesn't want you to know about for speeding your PC up. Microsoft is extremely invested in making your PC run as well as possible, and if removing old entries from the Registry made a significant difference, Windows would do it for you automatically.

You can make your PC run a little faster by upgrading your RAM to the maximum it supports, removing programs from the start-up group (especially your antivirus software) and uninstalling programs you don't need. But most of the slowdown comes from the inexorable bloating from Windows updates building up

over time. If you want a noticeably faster PC, buy or build a new one.

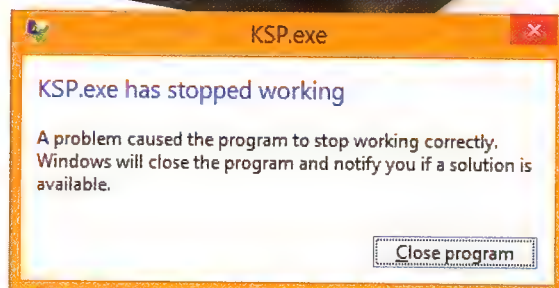
The other thing people complain has got worse over time is the heat output — especially from a laptop. Older laptops run hotter because they are trying to run newer games on older hardware, so the CPU and graphics card are running at full power more of the time. They also have collected some dust, which interferes with cooling. You can't do anything about the former, except upgrade, and I'd argue that you shouldn't do anything about the latter either. I have never dismantled a laptop and felt that things were in better shape afterwards.

If your laptop is running hotter than it used to, try not to use it on the bed, where the duvet is going to block the vents, and hope that the graphics card doesn't blow before it comes time to upgrade. Remember, heat by itself isn't really a problem.

Don't try and level your PC up, like a character in an MMO.



Abrupt game crashes are usually bugs in the game or its mods.



4 RANDOM WEIRDNESS

"Sometimes it just freaks out for no reason at all"

There are three kinds of random fault: loose connections, overheating and memory errors. You can tell the difference quite easily. If it freaks when you pick it up, it's a loose connection: some component or wire isn't quite making the connection it's supposed to, or at least isn't doing it reliably.

If it freaks when you've been watching movies or playing games for a while, perhaps accompanied by overly enthusiastic fan noise, it's overheating. Everything else is a memory glitch. You can fix memory glitches by replacing your RAM and the other two usually can't be fixed, so you should just replace the RAM anyway, in case you were wrong about which kind you have.

Random weirdness that happens only extremely occasionally isn't worth doing anything about. For instance, if my PC reboots itself spontaneously once a week, I would rather take a few calming breaths and get on with my life than waste several days hunting down a fault that

is extremely hard, if indeed possible, to reliably reproduce.

On the other hand, if it reboots five times a day you can treat this sort of fault as Spontaneous Breakage and take appropriate measures by referring to that section above.

If your laptop runs hot while gaming, that's quite normal.

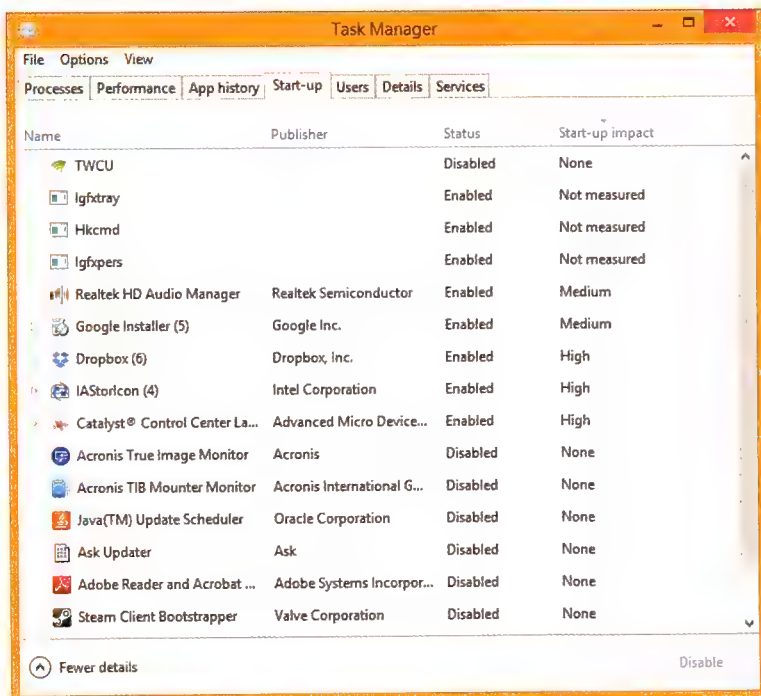


5 OMINOUS PORTENTS

"I'm sure I'm infected"

When people come to me for advice, I have learned to listen to the symptoms, not the diagnosis. Some people are convinced that their PC is constantly under attack and see unexplained behaviour or error messages as evidence of a virus infection or a hacker. If you are one of those people then stop it! Provided that Windows is updating automatically and you have changed the admin password on your broadband router from the factory default, avoiding viruses and hacking is mostly a question of not being an idiot when you click links. If your browser home page has changed by itself, or you can't open google.com, then you've probably got a browser hijack. This is malware, but it isn't a virus and it isn't Ebola. Download the Microsoft Malicious Software Removal Tool and be done with it.

Removing start-up junk is one of the few go-faster tips that works.



BONUS CATEGORY

RAINBOW CHASING

"I just want to try out the latest cool thing"

A PC is like a character in an MMO. When you start at level 1, you fight wolves and gradually you upgrade your equipment and can take on several wolves at once. But no matter how powerful you become, there will always be new gear you could get, and Chromium Ultra-wolf Den Mothers that you could be fighting. Rainbow-chasing is when you make life hard for yourself by trying to fix problems that don't exist. Overclocking your PC, just to get a bigger number in your benchmarking tool, say; or configuring a RAID0 array of disks, when hard disk performance isn't even a bottleneck for you. A lot of "What's the best way to upgrade?" type of questions are examples of Rainbow Chasing.

Upgrading is generally a good thing but there are two pitfalls you need to watch for. Don't upgrade your PC for the sake of it. You should upgrade so that you can run new software that exists now, not so that you'll be ready for any new software that might come along in the future. You can't tell how long it will be before something comes along that you need new hardware for — and by the time it does, your upgrade might not be graded far enough up. Secondly, you need to know

when to upgrade the components and when to upgrade the PC.

Here's what I do. With every other version of Windows, I will buy a new desktop or laptop with that version preinstalled. On the odd-numbered releases of Windows, I'll just upgrade the existing machine. When I buy a PC, I'll specify one notch above

Learning Python is straightforward, useful and free.



the current mid-range for CPU and graphics card, and get the maximum RAM that Windows currently supports. I normally get whatever the default hard disk size is at the time. After a year, if I want to run an application that needs more RAM or a faster graphics card, I'll upgrade. If it needs a faster CPU, I'll get a whole new PC. I have never run out of disk space on any PC ever.

A very common question for a Tech Guru is "Which new graphics card/laptop/motherboard do you recommend?" And the correct answer is to look at the latest slew of labs tests in the excellent magazine you're holding right now. We regularly cover graphics cards, motherboards, CPUs and look at full systems and laptops once a year. This leaves the question of how much you should pay for such things. The right price for a graphics card is \$400.

Learn to program

It's like Pilates for your brain.

Programming is an extremely helpful skill for a Tech Guru. Lots of command line operations become easier if you know a little programming, but more importantly, it really teaches you what a PC is.

Programmers are like Neo: they don't see files and icons, they see resource handles. Memory isn't just a quantity, like the fuel in your tank; it's a collection of discrete integers and floats and strings.

When you understand how the house is built, you'll know which walls you can safely remove and which not.

Programming means debugging, and the mindset you need to track down a tricky bug is exactly the same as the one you need to diagnose every other problem. Programming is like classical music theory for computer troubleshooting. You can teach yourself to strum some chords without it, but you won't become a great musician.

As soon as you can write a simple program, more complicated programs lose their mystique. And if you can write even a modestly useful app or a mod for a game, then your computer itself will be demystified to a

degree that is impossible to overstate. Programming is such an incredibly useful skill that it should be compulsory for all five-year-olds, never mind aspiring Tech Gurus.

Happily, programming is easier to learn now than ever. Python is a good language to learn first — it's a widely used, serious language, but it is designed to be quite readable and simple.

You can learn the basics for free in a few weekends at developers.google.com/edu/python and learnpythonthehardway.org.



What should happen?

Understand a normal boot sequence to recognise anomalies.

When your PC is switched off but still plugged into the mains (or laptop battery), the motherboard still receives power on the 5-volt standby rail. This provides power to the circuitry that monitors the power button. Pressing this button signals the board to tell the PSU to fire up and also pulls the voltage to 0V on the reset pin for the CPU. This puts the CPU into a known start state, with default values loaded into the registers, and sets the instruction pointer to the start address of the BIOS. Between 0.1 and 0.5 seconds later, the voltages from the

PSU have increased and the signals this by putting +5V on the Power Good line (pin 16) of the ATX connector. This tells the motherboard to release the reset line which allows it to return to +5V. The CPU now begins executing the Power On Self Test (POST) in the BIOS or UEFI code. This initialises the RAM and the PCI bus. If there is a problem at this stage you'll receive a series of beeps: a single beep indicates a pass, and control then passes to the video card, which executes its own video BIOS initialisation routine. Once the video subsystem is working,

control goes back to the BIOS or UEFI and loads the operating system. It's just a pretty wordy summary. What the BIOS does is to load the operating system into RAM. After that the Windows logo appears, the boot loader copies the registry into RAM and loads the remaining drivers. Once that is complete, the boot loader hands off to the Windows kernel and the login screen appears.



For a laptop, it's \$800 for a basic machine and \$2,000 for a fancy one. For a motherboard it's \$200, although the only reason to upgrade the board is when you upgrade the processor as well and if you are doing that, you may as well look at a whole new machine.

HELPING OTHERS

As a Tech Guru, you have to do more than diagnose the problem. You must also consider who is asking for your help and choose the best solution. By that, I mean the best solution for you.

For family members, you need the quickest resolution, because they will come back to haunt you if you don't fix it on the first try. Swapping RAM modules around is a quick and safe thing to try, but reformatting and reinstalling Windows will be like cutting the head off a hydra: you may fix the original problem but three more will grow in its place, as you try to restore all the drivers for their 15-year-old printers and off-brand sound cards.

With friends and neighbours you are much less invested, so wherever possible you should recommend new kit. My



If you can boot this far, the motherboard is probably fine.

experience is that this is generally what they are hoping you will do anyway; your pronouncement will be used as bargaining leverage with their spouses or parents, to justify a big spend. If you try and save them money, they will resent you for it and the next time their PC breaks, you'll be blamed for not euthanising it last time.

If you are fixing computers for customers, your overriding priority is to safeguard their data. Before you so much as open Device Manager, you should clone their entire hard disk onto a removable drive of your own. This will feel like a ridiculous precaution every single time,

until you actually need it, whereupon it will feel like the best advice anyone has ever given you. Remember: if data is lost for any reason while you are sat in front of the keyboard, you will be blamed. Cloned hard disks are like save points: you can afford to be more adventurous, if you know you can hit F9 and reload.

Is that all? Are you really a Tech Guru now? Of course you are! Gurus don't have all the answers, they just know how to remain calm under fire while they look for one. They know where to look and they know the answer when they see it. You can do all these things, and all that you need now is the self-confidence to carry it off. If anyone tries to call you an expert, by all means deny it. But if they call you a guru, just smile knowingly and humbly. ■



Pro music production with Linux

Demystifying JACK, discover with the help of **libremusicproduction.com** how you can plug into the world of professional audio on Linux.

JACK is the de-facto standard audio server for working with professional audio on Linux. JACK (a recursive acronym for 'JACK Audio Connection Kit') is a very powerful piece of software. Some new users find it confusing at first and that's understandable, with its complex interface and myriad settings. However, you only need to know the basics to get started and take advantage of its underlying power.

By the end of this guide, you will hopefully have a sufficient understanding of JACK and its workings so you can set it up, forget about it and get on with your work, utilising the power that it provides. Throughout the article we'll refer to any piece of software that supports JACK as being 'JACK aware'.

WHAT'S JACK

JACK is a sound server optimised for the demands of audio production work. There are a few main aspects to what it does. Let's have a quick overview of these now.

Settings: JACK controls your audio and MIDI settings. It allows you to choose your audio interface as well as all the important audio settings such as sample rate, buffer size and periods. These settings will be explained in

more detail further down.

Performance: Using JACK will allow you to achieve low latencies with both audio and MIDI. This means that if you are recording an instrument into your computer, you can monitor the audio back through your speakers, or headphones, without any perceivable delay. For a good overview, and visual description of latency, check out 'Latency and Latency-Compensation' at tinyurl.com/co2ute8.

Connections and Interconnectivity: This is JACK's strong point. Any inputs and outputs from your audio interface and/or JACK aware programs can arbitrarily be connected together. JACK not only deals with connections between programs but also within programs. Any JACK aware program uses JACK to manage its inputs and outputs. The beauty of this is that these connections are available for any other JACK aware programs to also connect to. They are not restricted to only being 'internal' input and outputs.

All of this makes JACK a very flexible tool and allows you to interconnect any number of JACK aware programs.

ALL IN SYNC

JACK can be used to sync multiple programs. This means that if you want to use the MIDI sequencer from one

program, and the audio sequencer from another, you can easily keep them in sync with JACK. Both programs will start and stop at the same time. Moving along the timeline in one program will be mirrored in any other programs that are set up to sync with JACK.

As you can tell, JACK is a very capable tool but don't be intimidated by its complexity. Using JACK does not need to be complicated. Just because it's capable of intricate workflows doesn't mean it's not also suited to more straightforward set ups. It will do what you want it to do, and is flexible enough to allow you to do more, if you ever need it. You can also happily work in one program and allow JACK to manage all its connections and never leave that program.

We now know what JACK is and what it's capable of. How do we use it? The first thing to note is that JACK itself is a command line program; however, there are various graphical managers for JACK that allow you to easily unlock its power. There are two main types of JACK managers, so you can choose the type that best suits you and your workflow. They can be categorised as JACK set up managers, which allow you to start up JACK with specific settings, and JACK connection managers, which primarily deal with making connections.

The various offerings of JACK managers combine these two aspects together to varying degrees. So, why would you choose one over the other? If you are doing all of your work inside of a DAW and you use no external programs, you might be happy with a JACK set up manager to just start up JACK with your selected settings. In such a case, you can make all your software connections from within your DAW of choice so there isn't as much need for an external connection manager anyway.

For people with a more modular recording set up, including multiple effects processors, recording and sequencing programs, a JACK manager more geared towards making connections might be best, especially as some modular programs don't have connection managers themselves. The following are the most popular JACK managers available:

Qjackctl is a very powerful, and popular, JACK manager. It allows you to access a large amount of JACK's settings and includes a connection manager, transport controls and even a manager for JACK session, which is a session management program. It presents itself in a small window, allowing you to dig into only the settings you need to access. It can also be minimised to your taskbar so it can get out of your way once you have set it up.

Cadence is an easy to use tool for setting up and starting JACK. It comes as part of the KXStudio distro and includes JACK bridges, which allow you to play normal desktop sounds, such as flash video, through JACK. Cadence can also start JACK on login, including JACK bridges. If you set it up once, there is very little maintenance thereafter.

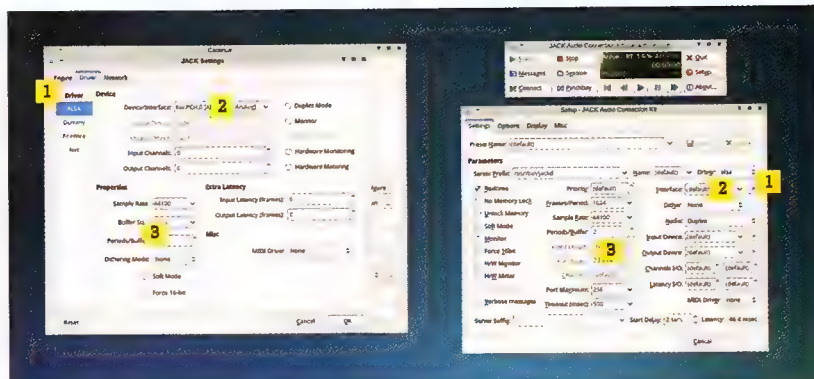
Patchage and Catia are two similar visual connection managers for JACK. They give you an overview of all your connections. Audio and MIDI ports are colour coded so it is easier to identify your connection types. Creating connections is as simple as clicking and dragging from an output port to an input port.

BASIC SETTINGS

If you are familiar with audio production on other platforms, you may already be familiar with some of the terminology used in relation to settings. If you are a new user this can be confusing as JACK has a vast array of settings. The main thing to remember here is that most of these settings are not important, at least not for starting off. If you don't know what they are, you probably don't need them just yet. Here is an explanation of the main ones that you need to worry about to get yourself up and running...

Buffer size (frames/period): Smaller buffer sizes produce less monitoring

You do know JACK?



1 SELECT A DRIVER

Ensure you select the Cadence driver tab (left window) and choose your driver, typically this will be ALSA.

2 SELECT INTERFACE

Ensure your interface is connected and powered, otherwise it might not show up here for you to select.

3 CHOOSE SETTINGS

Match your interface settings here. If you were wondering, frames/period is exactly the same as Buffer.

latency. A lower setting will make the computer work faster, which will allow for lower latency, but at the expense of increased CPU usage. Higher (larger) settings are more stable but you won't get low monitoring latency with them. If you are looking to achieve low latency monitoring, a setting between 64 – 256 should certainly give you usable results.

Sample Rate: Higher sample rates result in less latency, for the same buffer setting. This setting is dependent on the optimal settings for your audio interface and your own personal preference. Some people prefer to record at higher sample rates, others are happy with 44,100 (44.1kHz), which is CD quality. Another common setting is 48,000, which some interfaces work better at. The higher you go with this setting, the lower your latency will be, but you will also probably end up pushing your CPU harder, which can sometimes result in xruns (pops and clicks).

Periods/buffer: If you are making use of a USB device, you may achieve more stable low latency by setting this to 3. Otherwise, use a setting of 2. If you wish to achieve low latency settings, it can be a balancing act to find out what works best without pushing your CPU beyond the brink. If you don't need to monitor your audio through your computer with low latency, there is probably no need to push your computer any more than it really needs. You are better off staying with a higher setting and keeping reliability a high priority. If you have the option of hardware monitoring from your interface, it's wise to use this to monitor your recordings instead.

SETTING UP JACK

This guide assumes that you have a properly configured realtime set up. KXStudio (kxstudio.sourceforge.net) and AVLinux (www.bandshed.net/AVLinux.html) are two Linux distros that provide such an environment out of the box. We'll see how to set up JACK settings with both Qjackctl and Cadence. The following steps are relevant to both, with any exceptions noted...

- 1 Click on the Setup button in Qjackctl, or the configure button in Cadence.
- 2 Make sure that the realtime option is enabled (engine tab in Cadence)

JACK Aware

Any software that supports JACK is referred to as being JACK aware. This means that all its audio and MIDI inputs/outputs are managed through JACK. The idea of a DAW using another routing system can be a bit confusing at first. The way to think of this is by creating a parallel. If you are used to your DAW managing all your connections, think of JACK in the same way, except that it is system wide. Any software that is JACK aware can be plugged into this system, similar to how a DAW would add plugins. The difference is that JACK allows you to have precise control of how to route anything you connect to it.

Monolithic

Monolithic set ups are where you do all your work in one program. This is the most common approach people using Windows and Mac audio software will be used to. In Linux, JACK allows for very modular set ups, although some applications are fully featured and can also be used as monolithic set ups, eg. Ardour and Qtractor.

- 3** Select your audio driver (make sure driver tab is selected for this in Cadence). If you are using a Firewire device, select Firewire. In any other cases, leave it at ALSA.
- 4** Select your interface from the interface drop down menu.
- 5** Choose the settings for your interface.
- 6** Click OK to apply settings.
- 7** Press start!

In Qjackctl, do not touch the name field. Some new users like to give their JACK server a name but this can cause JACK not to work as expected. Unless you know what you are doing, leave this alone as it will cause more hassle than it's worth.

Once you have these settings set up, you can then use any JACK aware programs and they will run with those settings. Some programs will allow you to change your buffer size, so that you can adjust audio latency without having to restart JACK.

So, even though JACK is very powerful, you needn't be intimidated. At its most basic, it is very easy to set up your interface and get started. Like with any decent program, you can learn more about the power of JACK as you go along but don't get too bogged down starting off when all you really want to do is learn to use some new software.

If you are having any trouble at all getting JACK to run, or to recognise your interface, just make sure your interface is both connected and turned on before opening up your JACK manager. If you are still having any issues, as ever, try rebooting your system while your interface is still hooked up.

JACK SYNC

Another aspect of JACK that can be useful is JACK sync. Not only can you interconnect programs, you can also make sure that their transports run in perfect synchronicity.

We take a quick overview of how to do this by means of a demonstration that you can follow here...

Step 1: First of all, start running JACK via your preferred JACK manager.

Step 2: Next start up the programs

you wish to sync, in this case Ardour and Hydrogen. You'll need to make sure the setting within these programs are correct first.

Step 3: By default, Ardour is set to be JACK timemaster, which is what we want. This setting can be found by navigating to 'Session > Properties' and going to the timecode tab. We will leave this enabled for now though.

Step 4: Next, we click on the Internal button on Ardour's toolbar. This will change to JACK, which means that JACK will now follow Ardour as timemaster.

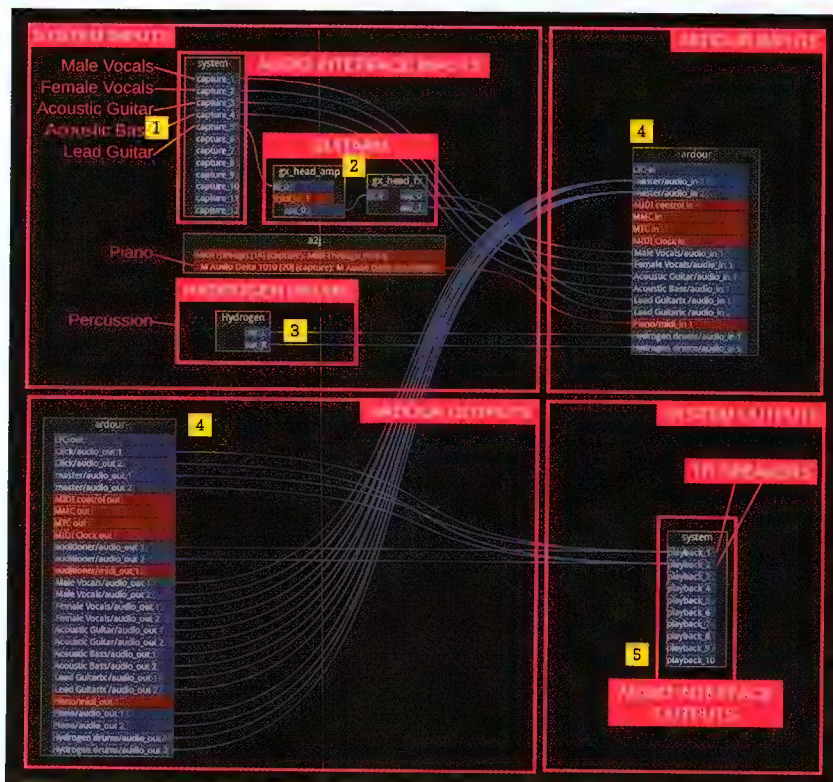
STEPS FOR HYDROGEN

- 1** Navigate to 'Tools > Preferences'. In the Audio System tab, make sure JACK is chosen as the audio driver and restart Hydrogen.
- 2** Now you will see two timemaster buttons showing up in the toolbar. Make sure that J.trans (Jack transport) is enabled. This means that it will follow JACK transport, which is now being controlled by Ardour.
- 3** Now both programs will be in sync when you roll their transports. Additionally, as Ardour is timemaster, you can change the tempo in Ardour and this will be reflected in Hydrogen, or any other slaved program.

The fact that JACK manages audio and MIDI ports, as well as allowing any programs using them to sync up makes it a very powerful tool. This enables very modular set ups to be created using JACK. For anyone interested in modular

JACK into Patchage

- 1** **AUDIO INTERFACE INPUTS**
Your main inputs for the track are listed here.
- 2** **GUITARIX**
A virtual guitar amp, it'll act on the signal exactly as a real amp.
- 3** **HYDROGEN DRUMS**
The GNU/Linux drum machine inputs to Ardour.
- 4** **ARDOUR**
Brings the all-important editing, recording, and mixing element.
- 5** **AUDIO INTERFACE OUTPUTS**
Inputs are mixed here and sent to the outputs.



INSTRUMENTS AND INPUTS

MALE VOCALS	INPUT 1
FEMALE VOCALS	INPUT 2
ACOUSTIC GUITAR	INPUT 3
ACOUSTIC BASS	INPUT 4
LEAD GUITAR	RUNNING THROUGH VIRTUAL GUITAR AMP, GUITARIX
PERCUSSION	HYDROGEN DRUM MACHINE SYNCED UP
PIANO	MIDI KEYBOARD PLUGGED INTO MIDI INPUT WITH VIRTUAL PIANO PLUGIN ON TRACK

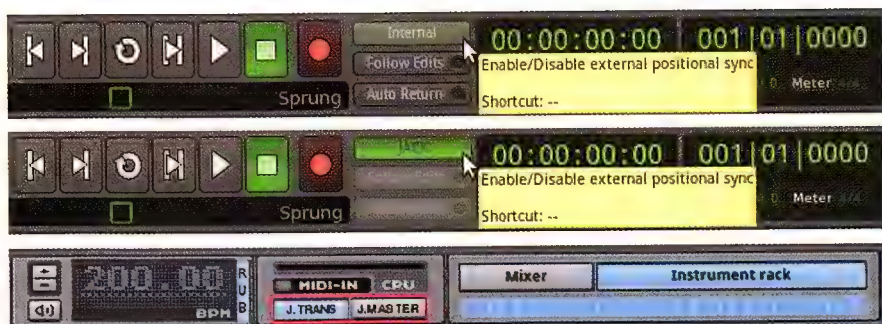
set ups, we recommend you look into session management, particularly Non Session Manager, to explore the possibilities of managing modular set ups with these tools.

MAKING CONNECTIONS

Let's create a recording scenario to demonstrate how to make connections using JACK. Here is the scenario we'll be using Ardour to record the following instruments:

The built in connection manager in Ardour is used to make these connections, but the logic is the same whichever connection manager you use. Below you will see a mixer window set up in Ardour. Out of shot we also have Guitarix and Hydrogen both running. Note the highlighted row. All connections are already made, including connections with Guitarix and Hydrogen.

To make these connections in Ardour, left click on the input buttons shown in the highlighted row. This will show a window from which you can select your input. In this case we wanted to route the second input from the audio



To sync programs, you need to make sure that one is master, and the other/others are slave.

interface into the second track (female vocals), so select capture 2 by ticking its box. Repeat the same steps for each other track until all the connections are set up how you want them.

Something to note here is that all these connections made will show up in any other JACK aware programs, for example, if you look at the connections window in Guitarix, you will also see the connections there that are made from within Ardour. This is because it's not the programs that make the connections. They use JACK to manage the connections and tell it what to do. Remember, JACK is your routing system and these programs are only using it. The following is a complete overview of all connections broken down so they are easy to understand.

Patchage is the best to illustrate something like this, open it up and check it out – note the colour code, audio ports are in blue and MIDI ports are in red. All connection managers have their positives and negatives. While it is very straight forward for a smaller amount of inputs and outputs, Patchage can get messy and hard to decipher with large amounts of connections. Ardour's built in matrix connection manager is very good for

very large numbers of connects as you can deal with them across categorised tabs. This makes it much neater.

This is a basic session but it demonstrates how audio and MIDI connections work in JACK. It also incorporates JACK applications external to DAW, one of which is in sync with JACK. Try out all JACK managers/ connection managers and see what you find you're most comfortable with and what best suits your workflow. They all do the same thing, they just do them in slightly different ways. In the end, you are using the same logic to make the same connections.

The best thing about JACK is that it doesn't lock you into any single workflow. We've seen how to sync programs and make connections between them but if you want to do all your work in one DAW and never leave it, you can do that too. JACK makes no assumptions. It leaves all options open to you, to take advantage of at any time, and makes various workflows possible, monolithic or modular. If you find the tools you like, JACK will make whatever set up you have in mind possible.

Modular

Modular set ups are where more than one program is used in a set up. JACK allows you to connect and sync various audio programs together so you can benefit from the strengths of individual applications. Session management can be used to manage and recall complex set ups. One suite of modular applications is the Non Suite, which includes Non Timeline, Non Mixer and Non Sequencer, although any JACK aware application can be incorporated into a modular set up. The Non Suite also includes a very intuitive session manager called Non Session Manager. a



The connection matrix within Ardour is an easy way of managing many connections.

how to

» QUICK TIPS

Experts solve your computing problems

APC and its readers can be one giant helpdesk. If you have a technical problem, chances are one of us can solve it.

HARDWARE

BUILDING A RIG FOR PHOTO EDITING

I'm currently contemplating a PC build that is primarily for Adobe Photoshop and Lightroom 5 use, but with occasional gaming capability. I am also looking for a machine that hums on the net and for media streaming. I am looking for a build for less than around \$2,000. Would one of your recent PC Builder systems serve this purpose? Maybe an existing high-end build but with a lesser graphics card? Or maybe an existing mid range build but with more RAM? Would you be able to provide any advice in this regard? Any existing internet articles for imaging type rigs always seem to be way out of date.

— Gary Legg

For a Photoshop and Lightroom 5 box, you should be fine with a quad-core Haswell-refresh (or Devil's Canyon) CPU. A quad-core Core i5 will work but there will be times when Photoshop and Lightroom 5 will see a boost from the Hyper-Threading in a Core i7 CPU. Photoshop does need a moderate GPU to enhance performance. Since you intend to also play games, you should probably get a decent GPU in the \$400 range, like a GeForce GTX 970, for your gaming. A card in that range should work just fine with Photoshop CC. Lightroom 5 performance is a little harder to predict as it's not GPU accelerated and does on occasion need lots of cores. To sum up: buy a Core i7 Devil's Canyon CPU, a \$400 GPU, and maybe 16GB of RAM, or even 32GB if you work with very large files in Photoshop, and then sink most of your money into a large SSD, a large hard drive, and an adequate system to back up those files, too.

APC staff

LINUX

CAN YOU HAVE TOO MUCH LINUX?

I have an ageing — some might say aged — laptop that has grown too old to run any meaningful version of Windows. However, I am very fond of it and have given it Linux Mint, dual booting in XCFE and KDE flavours. Unfortunately my



High-end graphics cards aren't just for gaming — they can be useful for accelerating video and photography work too.

knowledge of dual booting is only sufficient to be dangerous. Since I installed KDE, it has become the default boot option, but both I and my laptop would prefer XCFE to be the default. I can only think of something stupid like reinstalling in the reverse order, but I feel certain that you would know of a more elegant solution.

— Julian Cameron

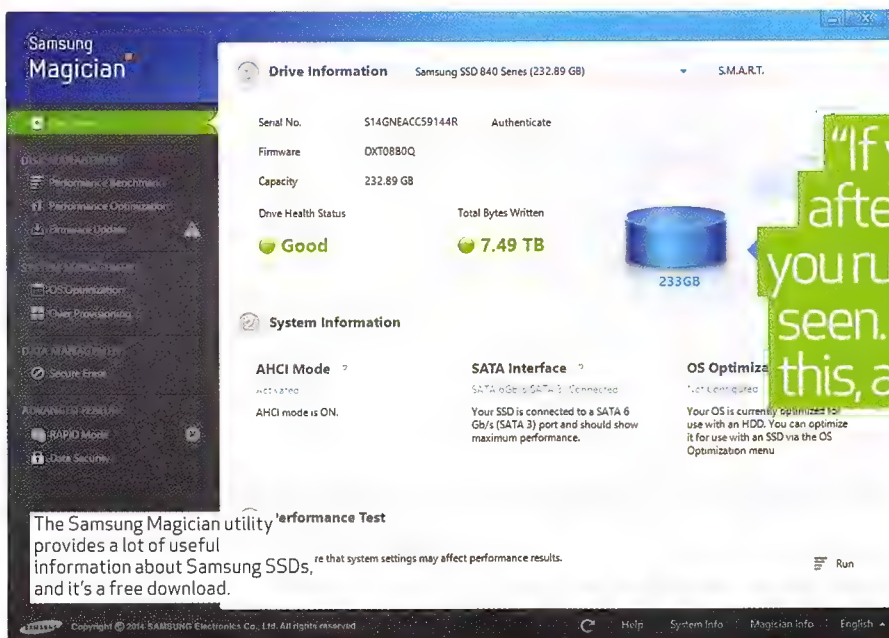
When booting Linux, the default OS is defined by the grub.cfg file in /etc/default/grub. Each OS gets a section in the file that begins with something like 'menuentry "Linux Mint yadda

yadda"... and then some configuration parameters enclosed by curly brackets. The default OS is defined by the line that says 'set default = "0"'. If you change the 0 to a 1, you'll change the default to the other OS. If you aren't comfortable with hacking grub.cfg, or you intend to change it often, you should probably install the Grub Customizer utility. This is available as a Personal Package Archive and you can install it with the following terminal commands:

```
sudo add-apt-repository
```



You can prioritise different OSs in grub by changing the 'set default' value.



"If you try to enable AHCI after Windows is installed, you run into issues, as you've seen. Luckily there's a fix for this, and it involves good old registry hacking."

GTX 750 Ti would have enough horsepower to run 4K resolution with light gaming, or do I need to go bigger? I want to spend as little as possible and I'm drawn to Maxwell's low TDP.
— Dan

```
ppa:danielrichter2007 grub-
customizer
sudo apt-get update
sudo apt-get install grub-
customizer
Luis Villazon
```

HARDWARE

SSDs AND AHCI AWKWARDNESS

I have a five-year-old PC, running on an ASUS P6T Deluxe mobo with a Core i7 processor that still performs quite well on most games I play (after a few graphics card replacements). However, I did recently upgrade my main storage from a Velociraptor 300GB hard drive to a Samsung 840 EVO SSD, and I'm having an issue with it. I duly went through the process outlined by the Samsung Data Migration software and hooked the drive up via the provided USB adapter, cloned the drive, detached the old hard disk, attached the SSD, and booted. The PC booted with no issues, and the drive works fine, but it seems slower than I had expected. However, when looking at the Samsung Magician software, it says the drive is operating in IDE mode, and not AHCI mode, and it cannot tell me about the SATA interface details. I then went into the BIOS and changed the settings for the hard drive interface to AHCI and rebooted. The system began to boot, did the Windows bloom thing, and then immediately rebooted. I've tried all of the possible settings in the BIOS, attached the drive to a different physical SATA port, and nothing works.

— John Burgess

What you're seeing is an age-old problem with SSDs, and it's normal. You can't just change the BIOS setting from IDE to AHCI or the system will Blue Screen, as you witnessed. The reason why is the AHCI setting allows new behaviour on the SATA port,

including Native Command Queuing for the drive and the ability to hot-swap, so you need to have extra drivers installed, depending on the SATA controller in question, which typically occurs during Windows installation. If you try to enable AHCI after Windows is installed, you run into issues, as you've seen. Luckily there's a fix for this, and it involves good old registry hacking. The instructions vary according to whether you are using Windows 7 or 8, so we'll refrain from typing them here, but you can easily find them online. Just be sure your data is backed up before messing with the registry.

HARDWARE

4K ON A BUDGET

I want to upgrade to a 60Hz 4K panel (who doesn't?), and about the most demanding game I run is Age of Empires II HD from Steam. I think the maximum resolution my AMD Radeon HD 6870 can display is 2,560 x 1,600 and it makes my office get hot during gaming, so I'm looking for a new video card. Do you think an Nvidia

You're right that the AMD Radeon HD 6870 does not do 4K. But luckily for you, we actually have a 4K monitor and an Nvidia GeForce GTX 750 Ti on hand, though we don't know what CPU you're using. We tested the gear with a quad-core Intel Core i5-3470, and we got a solid 60fps when we ran Age of Empires II HD. A desktop Core i3 should also get the same results, since the game doesn't use more than two CPU threads. As long as you're not playing recent strategy titles or AAA first-person shooters, the GTX 750 Ti should sustain a good frame rate in less visually complex games.

HARDWARE

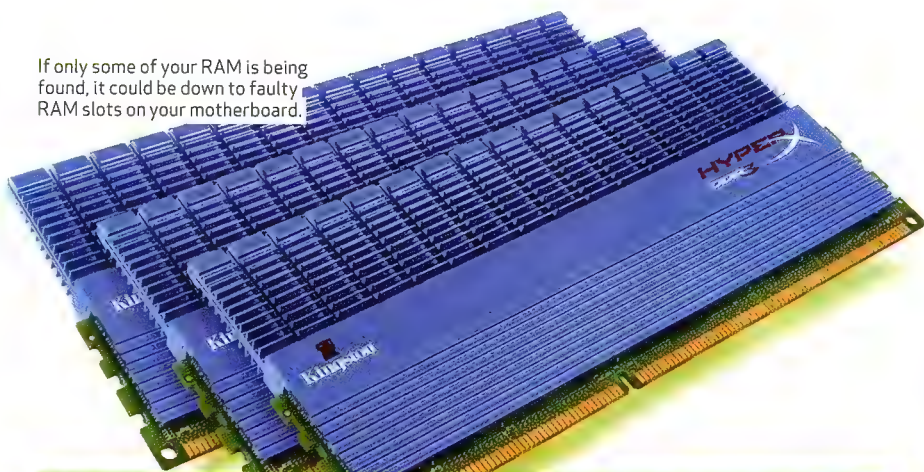
WILDLY FLUCTUATING RAM

I have a CAD workstation built by myself, and I have an intermittent problem. When I bought the motherboard, I got three sticks of DDR3 RAM and it only showed 4GB in Windows. I swapped the RAM around with no change, so I assumed one of the sockets was faulty. I persevered for a few days, then



Surprisingly enough, you can run older games at 4K with a lowly GeForce GTX 750 Ti.

If only some of your RAM is being found, it could be down to faulty RAM slots on your motherboard.



"There's no silver bullet. Well, there is, but it costs as much as a new motherboard. It's also the same shape as a new motherboard. Because it's a new motherboard."

Windows started to show 6GB. I needed more RAM due to my CAD requirements. I inserted three new sticks and it only showed 8GB instead of 12GB. After a few days Windows showed 12GB. It has been like that for almost five years, until I updated my graphics card to the Quadro FX 1800 and now it's back to showing 8GB of RAM. A week went by and guess what? It's saying 12GB again, so I am at a loss to what the hell is going on.

— Stephen Nisbet

If there's one thing we've learned researching APC's Q&A, it's that the more complicated and impossible a problem seems, the simpler the solution actually is. Truly intermittent faults are only caused by one of two things: thermodynamics or kinetics. Either something got too hot or something got jolted. In your case, it's the latter. Your motherboard has a dodgy contact somewhere – probably near the RAM sockets, but that's not important. What is important is that opening the case and installing cards makes the board flex a bit and this is evidently enough to disturb the connection. You can always hope that it beds back in by itself and gives you another few years of relatively consistent performance, but there's no silver bullet. Well, there is, but it costs as much as a new motherboard. It's also the same shape as a new motherboard...

Luis Villazon

WINDOWS

COUNTDOWN TO DISASTER

My desktop has a blue screen with a white font and digital percentages ascending at

great speed until 100% then it instantly and automatically shuts down while I'm operating. What could be the possible problem and how can it be rectified?

— Wellington Mwale

That'll be the Blue Screen of Death. Most previous versions of Windows stop there to give you a chance to read all the vague and cryptic text before you reboot. But in Windows 8 there is a percentage counter while it collects 'error info' and then it reboots automatically. If your PC is running from an SSD, that counter will fly by pretty fast. So now we've established what your error screen is called, what is to be done about it? Well first of all, you need to get past the whole 'of Death' part. This is an exaggeration (absolutely every person on the planet does this). You won't die. No one will die. Your PC has just crashed. Unless it

was controlling your dialysis machine or the damping rods in your home nuclear power plant, you'll be fine. These errors should really be called the Blue Screen of Stopping Suddenly. Although stopping suddenly is a major cause of death among skydivers, in your case it just means that you need to check that your RAM isn't faulty and then roll back any recent hardware or software changes you have made.

Luis Villazon

HARDWARE

SSD & HARD DRIVE DECISIONS

When installing an SSD, besides the OS, what other programs should be installed on it? I had an SSD on my PC, but it died, and I had a computer tech move everything over to my regular drive. The original SSD was only 60GB, but I am planning on buying a larger one. Should I move all of my programs over or just my web browsers?

— William R Miller

This is quite a common situation. You have your smallish SSD sitting there, and a "regular drive" to use your words, so how do you split up your data and programs? The answer is actually quite simple, and is dictated mostly by the capacity of the drives in question. Since most of us are rocking SSDs ranging in size from 128GB to 512GB, we simply can't put all of our data on the SSD like back in the day when we had one hard drive that held everything, including our OS, data, and all our programs. Therefore, the division is quite simple. You put your OS and installed programs (including games) on the SSD, and all your "data" on the hard drive. You can then change all the shortcuts in Windows to be on the hard drive by right-clicking those shortcuts and fiddling with their properties.

APC staff ■

You'll need to check the fine print on Windows 8's new Blue Screen of Death in order to troubleshoot problems.



Your PC ran into a problem and needs to restart. We're just collecting some error info, and then we'll restart for you. (0%) (complete)

Provide assistance with Excel buttons

Helen Bradley shows how to create Excel solutions using buttons.

Clicking a button to run a macro is a simple way to perform complex tasks. This month, we'll use two to create a worksheet that offers simple formatting help to users.

This solution adds a button to a worksheet that can be clicked to reveal additional clickable buttons which themselves apply custom formats. Each button type is created and coded in different ways.

CREATE THE SOLUTION

Start in the Visual Basic Editor and type this code – it adds and removes the CommandButtons at runtime and does the actual cell formatting.

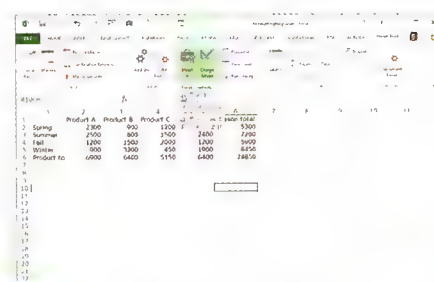
```
Sub AddFormattingButtons()  
Worksheets("Sheet1").Activate  
On Error Resume Next  
If ActiveSheet.Shapes("Button  
1").TextFrame.Characters.Text =  
"Hide Buttons" Then  
If ActiveSheet.DrawingObjects  
("customButton1").Name <> ""  
Then  
ActiveSheet.DrawingObjects  
("customButton1").Delete  
End If  
If ActiveSheet.DrawingObjects  
("customButton2").Name <> ""  
Then  
ActiveSheet.DrawingObjects  
("customButton2").Delete  
End If  
ActiveSheet.Shapes("Button  
1").TextFrame.Characters.Text =  
"Show Formatting Help"  
Else
```

```
If Not (ActiveSheet.  
DrawingObjects  
("customButton1").Name <> "")  
Then  
Set myButton1 = ActiveSheet.  
Buttons.Add(150, 100, 225, 25)  
myButton1.Name =  
"customButton1"  
myButton1.Caption = "Apply #  
Formatting to selection"  
myButton1.OnAction =  
"Format_currency"  
ActiveSheet.Shapes("Button  
1").TextFrame.Characters.Text =  
"Hide Buttons"  
End If  
If Not (ActiveSheet.  
DrawingObjects  
("customButton2").Name <> "")  
Then  
Set myButton2 = ActiveSheet.  
Buttons.Add(150, 150, 225, 25)  
myButton2.Name =  
"customButton2"  
myButton2.Caption = "Toggle  
Total Lines on Selection"  
myButton2.OnAction =  
"Toggle_Total_Lines"  
ActiveSheet.Shapes("Button  
1").TextFrame.Characters.Text =  
"Hide Buttons"  
End If  
End If  
End Sub  
Sub Toggle_Total_Lines()  
flag = False  
If Selection.  
Borders(xlEdgeTop).LineStyle <>  
xlContinuous Then  
Selection.  
Borders(xlEdgeTop).LineStyle =
```

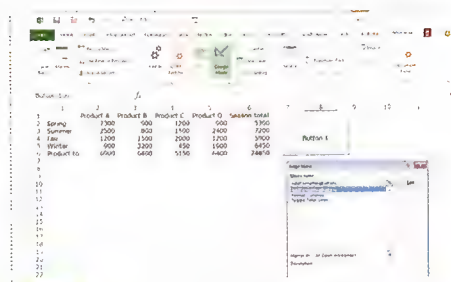
```
xlContinuous  
Selection.  
Borders(xlEdgeTop).Weight =  
xlThin  
flag = True  
End If  
If Selection.  
Borders(xlEdgeBottom).LineStyle  
<> xlDouble Then  
Selection.  
Borders(xlEdgeBottom).LineStyle  
= xlDouble  
Selection.  
Borders(xlEdgeBottom).Weight =  
xlThick  
flag = True  
End If  
If flag = False Then  
Selection.  
Borders(xlEdgeBottom).LineStyle  
= xlNone  
Selection.Borders(xlEdgeTop).  
LineStyle = xlNone  
End If  
End Sub  
Sub Format_Currency()  
Static numFormat As Integer  
If numFormat = 0 Then  
Selection.NumberFormat =  
"_(€* #,##0_);_(* (#,##0);_*  
""-""_);_(@_)"  
Else  
Selection.NumberFormat =  
"#,##0.00"  
End If  
numFormat = Abs(numFormat -  
1)  
End Sub
```

The button on the form is added after the steps below. The text on this button is changed when the macro runs. ■

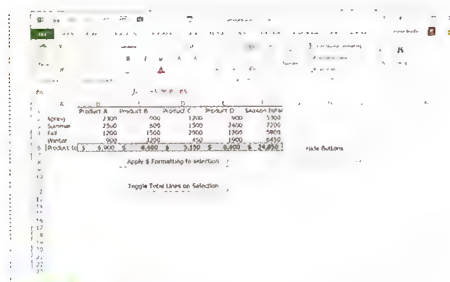
Add a button to the worksheet



1 Download the macro file from apcmag.com/magstuff.htm. Click the Developer tab. Click 'Design Mode > Insert' and click 'Button (Form Control)'.



2 When the 'Assign Macro' dialog opens take note of the button number. Click 'AddFormatting Buttons' to assign the macro to the button. Turn Design Mode off.



3 If the button number is different to 'Button1', change code references to the button's actual number. Click the button to add formatting buttons.

Own your cloud data

Off' accused of having his head in the clouds, Jonni Bidwell heads for the stratosphere. Also, the latest release of OwnCloud.

OwnCloud has recently had a bugfix release 7.0.1. Version 7.0.2 will be released by the time you read this and, as the kinks are ironed out, what is emerging is quite a remarkable product. Remarkable enough, to devote 4 pages to it? Yes, we think so.

You'll need your own server in which to house your cloud. This might be local or remote, actual or virtual, it doesn't really matter. What does matter is that, on the said server, you have a web server running that's accessible from whatever network you want to share on. If this is the internet then usual caveats about safety apply. For this tutorial we'll assume a working Apache setup, but the same ideas spouted here apply to Nginx or Lighttpd.

Your distribution's repos might already have the latest version of OwnCloud available, but if not the lovely OpenSUSE Build Service provides packages for popular distributions. Instructions are available at owncloud.org/install. On Ubuntu 14.04, for example, you would create the file `/etc/apt/sources.list.d/owncloud.list` containing the line:

```
deb http://download.opensuse.org/repositories/isv:/ownCloud:/community/xUbuntu_14.04/ /
```

Then (optionally) add the repo key to apt to suppress warning messages about foreign packages:

```
wget http://download.opensuse.org/repositories/isv:/ownCloud:/community/xUbuntu_14.04/Release.key
sudo apt-key add - < Release.key
```

And finally update the package database and install a shiny (or watery?) new version of OwnCloud:

```
sudo apt-get update
sudo apt-get install
owncloud
```

CLOUD PROVIDER

As a responsible cloud host, one of your duties will be enabling and enforcing https connections. To do this you need

to be in possession of a signedSSL certificate, and to tell your web server about it. (See the Generating a Self-Signed Certificate).

Owncloud adds its own configuration file `/etc/apache2/conf-available/owncloud.conf`. This contains an alias that will map `/owncloud` on your server to its default install directory `/var/www/owncloud`.

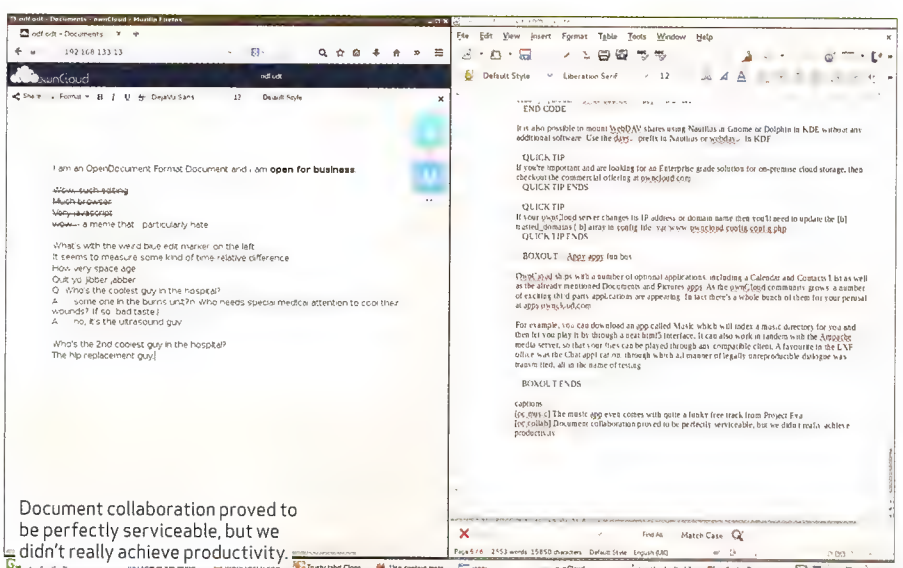
So navigate to <https://yourserver.com/owncloud> (replacing yourserver.com with your server's domain name or IP address). If you are using a self-signed certificate, then you will receive a warning about the certificate being untrusted. And rightfully so, but you know that you made the certificate, and you trust yourself, so you should add a security exception here. Even though visitors won't be able to verify the server's identity (unless you somehow shared the certificate's fingerprint with them), they will at least know that the connection is encrypted.

Your first job as cloud overlord is to set up an administrator account and

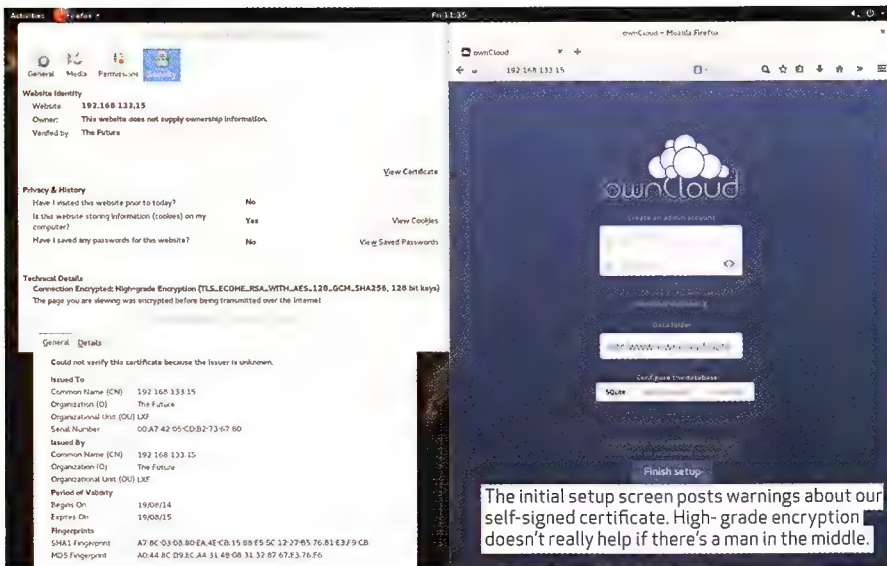
choose the format for the OwnCloud database. If you envisage a small cloud (such as cirrus uncinus) then SQLite will be fine, but if you have multiple users all co-operating/fighting over terribly important documents (and TPS reports) then SQLite will buckle under the strain and you will need a proper SQL database. We'll stick with SQLite for now, but note that it is possible to convert to one of the more grown up databases further down the line. Choose a suitable moniker for your admin account, use a good password and click Finish setup.

Bam! Owncloud is ready to go. You'll be invited to download the sync apps for desktop machines (Yes, there's a Linux client) and mobile devices, and instructed to connect your calendar and contacts. All in good time though. First of all we really ought to disable insecure http connections. So go to the menu in the top right and open the Admin panel. Scroll down until you find the Enforce HTTPS check box, which you should tick. Now logout and visit your Owncloud via `http://`. All

"This might be local or remote, actual or virtual, it doesn't really matter."



Document collaboration proved to be perfectly serviceable, but we didn't really achieve productivity.



going well you should be redirected to the <https://> site. Safe and sound.

CLOUD IS A WONDERFUL THING

Setting up user accounts is simple: Log in as Admin, select the Users option from the top-right menu, give you and your friends usernames and passwords, and share them appropriately. Setting up groups and quotas is also done from this page, so you can stop your users from wasting storage with their Barry Manilow MP3s. It's good practice to only use the Admin account for administrative things, so use your personal account for storing and sharing your files, photos and Michael Bolton tracks. To upload a file select the Files area from the top-left menu and either click the upload button or just drag your files onto the browser window.

OwnCloud 6 was already a pretty solid product, and while it's successor

lacks any major cosmetic differences, a significant amount of new functionality has been introduced, as well as a plethora of minor tweaks. One of its most touted new features is the ability to preview and edit Word files. In previous incarnations this was limited to OpenDocument formats only. The file format voodoo is all carried out through Libre/Open-Office, so you will need to install one of these, either on the OwnCloud server you just set up or on another machine set up as a file filter server. Libreoffice is pretty big though, and it seems rather inefficient to install this on a machine where the GUI or most of its features will never be used. On Ubuntu you can install it with:

```
# sudo apt-get install
libreoffice -no-install-
recommends
```

to cut down on the cruft a little. Installed this way the packages only weighed in at 116MB. Its up to you whether being able to work with obfuscated and inefficient file formats is worth this space investment – the open formats work fine without it, and you can also view PDFs in the browser too, through an adapted PDFjs viewer.

The old-style rigid Shared folder is no more, so items can be shared from anywhere in the hierarchy. Further people you share the item with are free to move it around their own folder structure as they see fit. Users can put time limits on public shares and admins can enforce these, as well as mandate password usage. OwnCloud has always had support for external storage sources, be it (S)FTP servers, Windows shares, OpenStack object storage or third-party storage, such as Google Drive, Dropbox, Amazon S3. The exciting new addition here is the ability to share between OwnCloud installations – so-called server to server sharing. This is easy to set up, you can enable specific OwnCloud shares for the users of your choosing, or if you trust them you can grant them the freedom to connect to the OwnCloud resources of their choosing. Obviously they will require their own login details for each resource they want to access.

Server to server sharing takes the headache out of the otherwise awkward process of downloading a file from one cloud to the desktop so that it can then be uploaded to another cloud. Not to mention all the synchronisation issues that arise from having three different versions of a file flying about. But OwnCloud promises yet more in future versions, having a vision of a so-called 'federation of data' wherein one can seamlessly share files between

Generating a self-signed certificate

If you have your own domain name then you can obtain a free certificate from www.startssl.com, or a paid-for one from any number of other registered authorities. However you can also generate and sign your very own certificate if you want, as follows:

```
sudo openssl req -x509 -nodes -days 365
-newkey -keyout /etc/apache2/ssl/owncloud.
key -out /etc/apache2/ssl/owncloud.crt
```

You will be asked for some address and company details, as well as a Common Name (which you should set to your domain name if you have one) and a contact email address. This will generate a self-signed (X.509) certificate, which will be valid for one year and will include a 2048-bit RSA (the default) key. We need to tell your web server to use these credentials for handling connections on port 443. A standard Apache installation comes with a file `/etc/sites-available/default-ssl.conf`, which we can modify slightly to suit our purposes.

The `<VirtualHost _default_:443>` tag applies to any

VirtualHost that isn't explicitly mentioned elsewhere in the block, so if you don't have any other configuration in place this is as good a place as any to add the certificate information.

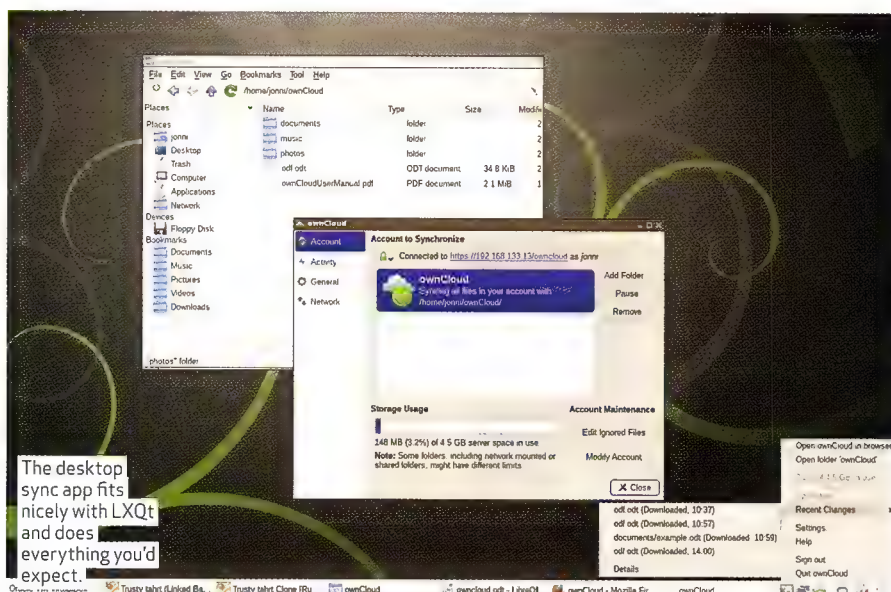
You need to change the `SSLCertificateFile` and `SSLCertificateKeyFile` directives as follows:

```
SSLCertificateFile /etc/apache2/ssl/
owncloud.crt
then:
SSLCertificateKeyFile /etc/apache2/ssl/
owncloud.key
```

You should also change the `ServerAdmin` email address and the `ServerName` address to your domain name or IP address. Now enable the Apache SSL module and our new configuration, either by using the `a2en(mod,site)` helpers provided in Debian-based packages, or by using a good old fashioned:

```
ln -s /etc/apache2/mods-available/ssl.conf
/etc/apache2/mods-enabled/
ln -s /etc/apache2/sites-available/default-
ssl.conf /etc/apache2/sites-enabled/
```

Restart the Apache daemon and you should be wired for SSL.



clouds without having to have explicit access to them. This goes one step further towards abstracting away the boundaries between servers, and someone on the APC team making a 'one cloud to rule them all' comment.

The web interface has received some polish too, being now much more friendly to mobile devices, although mobile users may be happy to use the dedicated apps. Documents are lazy loaded, so documents or extensive photo galleries are read piece-wise as you manipulate an ever-shrinking scroll bar. While this makes things appear initially faster, it can be a little awkward in some situations. Most notably in the Pictures app where there is currently no option to sort by date, so

if you just want to see the newest shots in a large folder, then prepare for some lengthy scrolling and wait times. There's a bug report filed about this though, and an improved lazy-load is earmarked for the 7.0.3 release.

SYNCING ON MY MIND

Apps exist for your Android or (shudder) iDevices so you can get your data while you're on the go, or too lazy to walk to your computer. The Android one is open source and freely available from other sources (such as F-Droid) if you're feeling impecunious. Unfortunately, the apps aren't quite as svelte as their Dropbox and Google Drive peers. In particular uploading multiple files has to be done one at a

Quick tips

- If you're important and are looking for an Enterprise grade solution for on-premises cloud storage, then checkout the commercial offering at <https://owncloud.com>.
- If you're too cool for setting up a web server and traditional install methods, then there are a few all ready to roll at <https://registry.hub.docker.com>.
- If your OwnCloud server changes its IP address or domain name then you'll need to update the trusted_domains array in the file `/var/www/owncloud/config/config.php`.

time, and there is no option to upload an entire folder. This might be a dealbreaker for some, but it needn't be: OwnCloud can share its files through the WebDAV protocol, and there are all manner of apps for syncing with such shares on your tablets and mobiles.

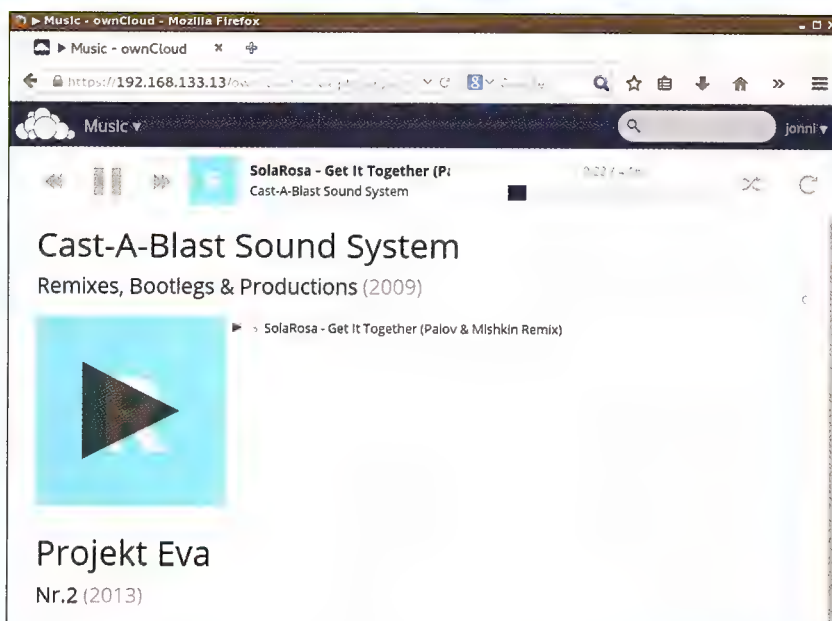
The official desktop client is a simple-but-functional Qt4 application, which sits nicely in the System Tray and lets you know when it's syncing in much the same way as its Dropbox equivalent. By default it will sync your entire OwnCloud account to the local directory `~/owncloud`, but you can pick and choose folders as befits your own cloudy proclivities.

You can set bandwidth limits too. The desktop client does look a bit

Appy appy fun bus

OwnCloud ships with a number of optional applications, including a Calendar and Contacts List, as well as the already mentioned Documents and Pictures apps. As the OwnCloud community grows a number of exciting third-party applications are appearing. In fact there's a whole bunch of them for your perusal at <http://apps.owncloud.com>.

For example, you can download an app called Music which will index a music directory for you and then let you play it by through a neat HTML5 interface. It can also work in tandem with the Ampache media server, so that your files can be played through any compatible client. A favourite, by a long way, in the APC office was the Chat application, through which all manner of legally unreproducible dialogue was transmitted, all in the name of testing.



The music app even comes with quite a funky free track from Project Eva.

"If you want to allow multiple users access then add a line for each of them."

awkward if you're using Gnome, with its disappearing System Tray, though, in theory, once you've got it all configured you shouldn't need to interact with it anymore. Obviously, the desktop client won't be much use if you want to sync to a remote machine though: In this situation you'll want to use the aforementioned WebDAV.

The davfs2 program works via the FUSE kernel module and enables you to view WebDAV shares as if they were local filesystems. To install the package on Debian-based distros is just a simple matter of: `# sudo apt-get install davfs2` and the package is certainly present in other distro's repos. You can optionally set the SUID bit on the executable so that non-root users can mount WebDAV shares. Debian and Ubuntu can do this for you with: `# sudo dpkg-reconfigure davfs2`

If you accept the warnings (it's pretty safe actually since the program drops its root privileges), then anyone in the webdav group will be able to mount WebDAV shares, so add your user to this group like so: `# sudo gpasswd -a username webdav`

Now make a folder `~/owncloud-dav` which will be our mount point. We also need to specify our OwnCloud login

credentials, which are stored in the file `~/davfs2/secrets`. This file may have been created for you during the reconfigure earlier, but you can easily create it manually if not. Since this file will contain sensitive data it is important to lock down the permissions: `# chmod 600 ~/.davfs2/secrets`

Add a line like the following to your secrets file:

```
https://yourserver.com/  
owncloud/remote.php/webdav  
username password
```

replacing the URL, username and password as appropriate. You will also need to add the following to `/etc/fstab` (which will require root privileges, hence `sudo nano /etc/fstab`):

```
https://yourserver.com/  
owncloud/remote.php/webdav /  
home/username davfs  
user,rw,noauto 0 0
```

Again, you'll need to replace the username with yourself. If you want to allow multiple users access then add a line for each of them. All going according to plan, users will be able to mount their OwnCloud folders with a

simple `# mount ~/owncloud-dav`

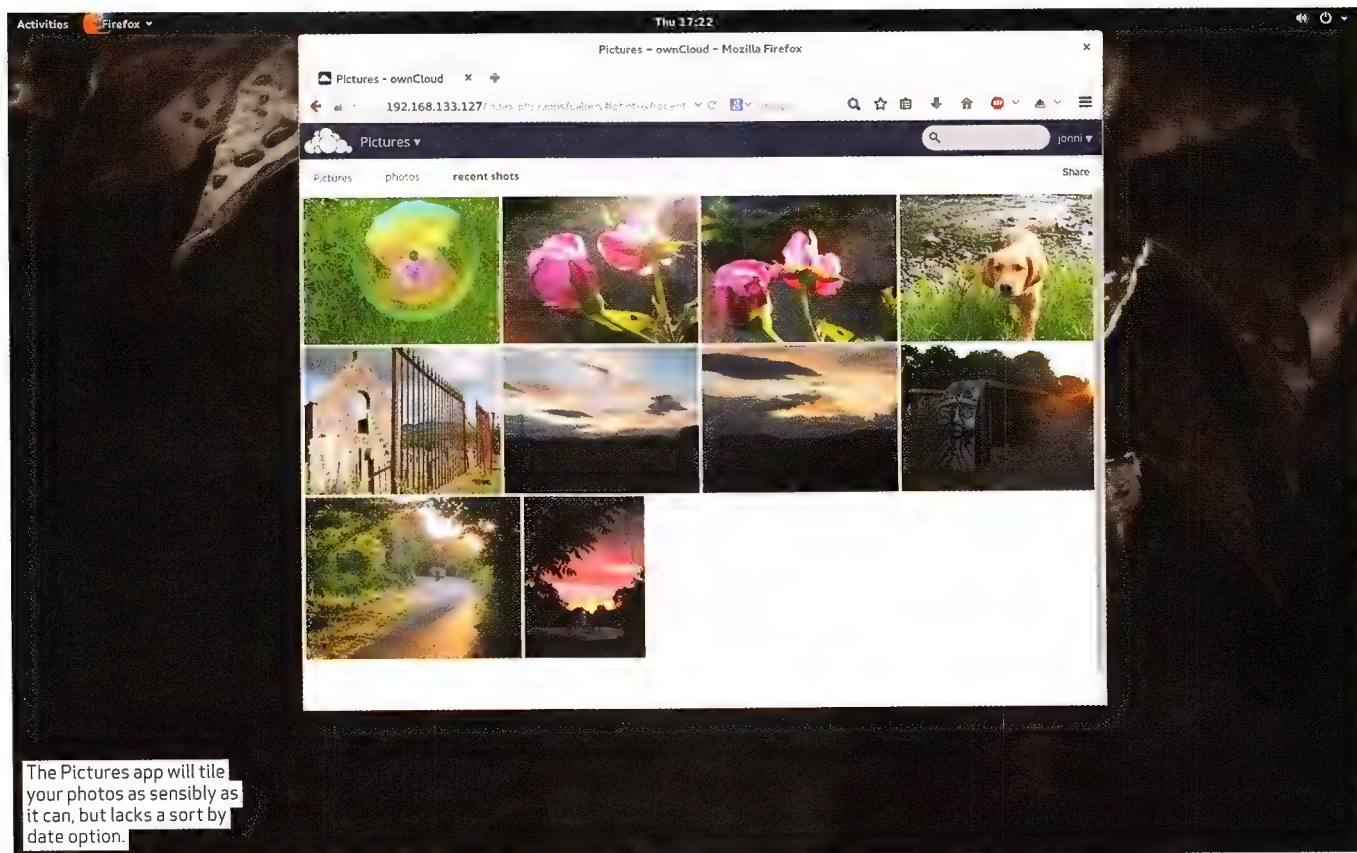
If you're using a self-signed certificate then you will get a warning about possible man-in-the-middle attacks, but we've been through this already. Users might want to automatically mount their OwnCloud resources automatically, which would normally just entail adding the above mount command to `~/bashrc`. However, the warning message will get annoying, so you can silence it and pipe an agreement by instead using the tricksy: `echo "y" | mount ~/owncloud-dav > /dev/null 2>&1`

It is also possible to mount WebDAV shares using Nautilus in Gnome or Dolphin in KDE without any additional software. You'll need to use `davs://` URI prefix in Nautilus or `webdav://` in Dolphin.

In the past year, about 300 developers have contributed new code to OwnCloud, which makes it one of the most active open source projects alive today and is a shining example of what open source can achieve.

As we conclude this tutorial, the OwnCloud Contributor Conference is underway in Berlin and the APC crystal balls tell us that the hackathon here will fructify great things and squash many bugs.

In a world where the big players and their massive data silos are hungry for your data, and are all too willing to move the goalposts on such trivial issues as privacy, maybe now is the time to make your data your own. ■



Get Windows 10 features now

Fancy a slice of Windows 10? Ed Ricketts shows you how to add many of its features to Windows 7 or 8 right now.

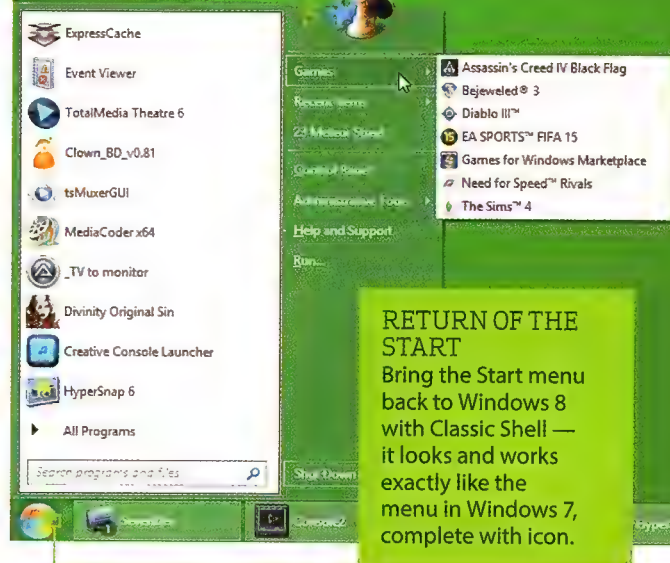
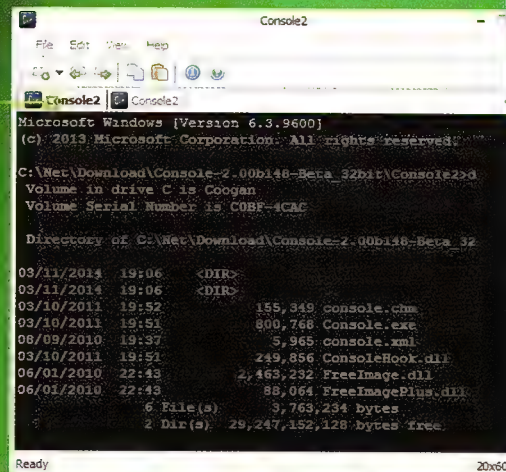
The release of Windows 10 is still quite a way off, and if you're not brave enough to try out the Technical Preview, you might be sighing in anticipation of all the new features Windows 10 will bring to the desktop and elsewhere — not least the return of the Start menu.

Worry not though, because you can replicate many of those very same features in Windows 7 and 8 using a variety of (mostly free) third-party programs, as we'll demonstrate in this guide. Some are quite well known — the amazing Classic Shell, for instance, has become a firm favourite among many Windows 8 users — but others you may not have known even existed. Once you discover them, you'll probably be hooked — and using them will get you ready to jump straight into Windows 10 next year.

IN COMMAND
Install a command prompt replacement to mimic the new version in Windows 10, with advanced features like multiple tabs.

A BETTER START

Customise the way the Start menu looks and acts. You can even bring back the Windows 95 style if you really want.

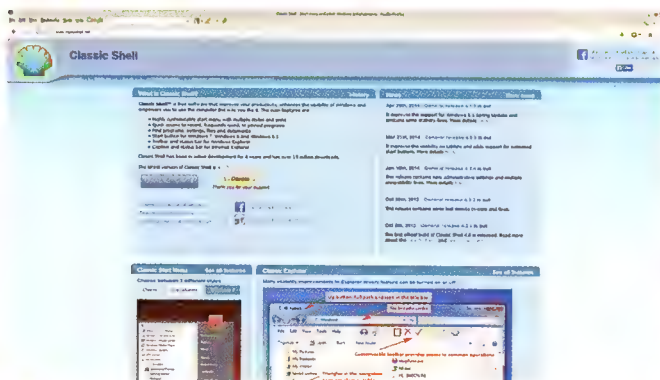


RETURN OF THE START

Bring the Start menu back to Windows 8 with Classic Shell — it looks and works exactly like the menu in Windows 7, complete with icon.

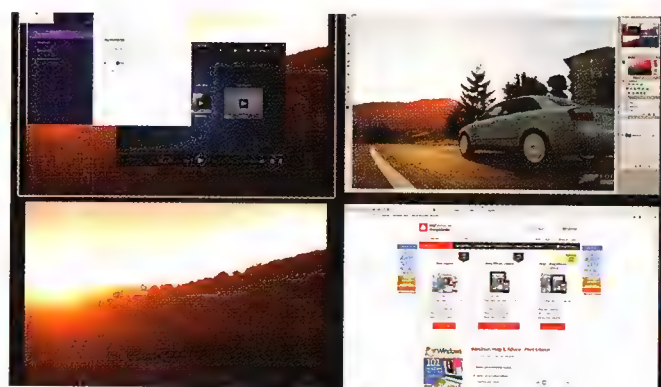
Mimic Windows 10's features right now

Why wait for the official release?



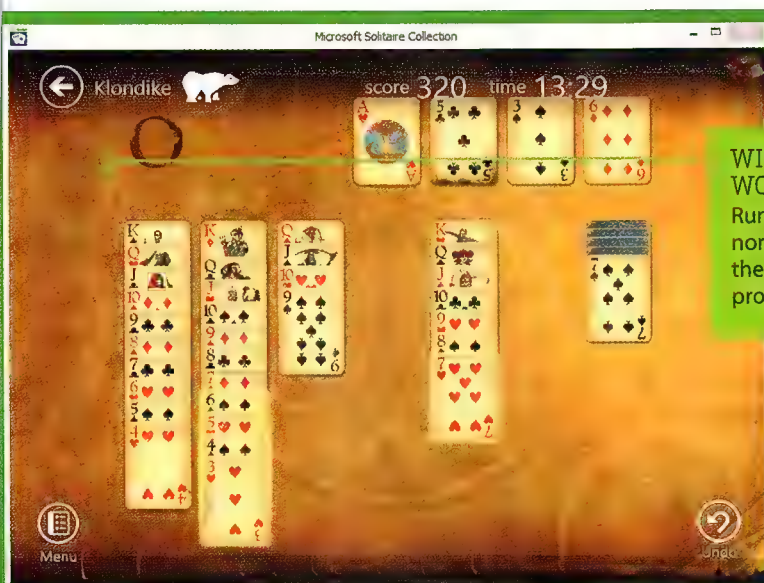
1 GET CLASSIC SHELL

One of the biggest gripes many people have with Windows 8 is the lack of a proper Start menu, which is probably why Microsoft is bringing it back in Windows 10, with some extra improvements. There are many utilities available to 'fake' a Start menu in Windows 8, but the best is definitely Classic Shell — and it's completely free.



2 INSTALL THE SOFTWARE

Classic Shell actually consists of three components: Classic Start Menu, Classic Explorer and Classic IE. If you just want the Start menu, you can safely ignore the other two parts. During installation, you can choose whether or not to install each component: just click and choose 'Entire feature will be unavailable' for Classic Explorer and Classic IE.



WINDOW ON THE WORLD

Run Modern apps in a normal window, and resize them just like any other program.

Jargon buster

COMMAND PROMPT

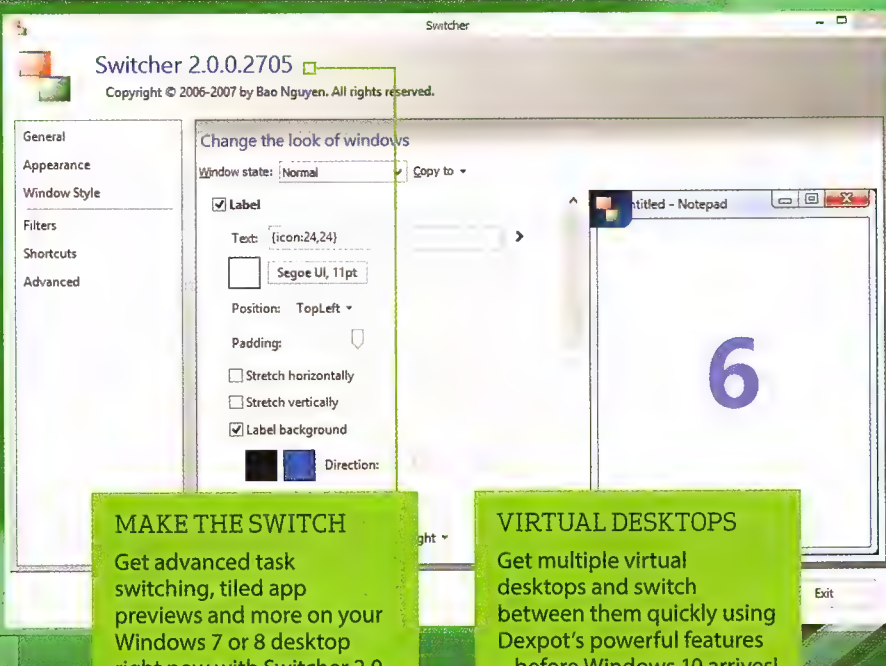
This enables you to type commands and navigate directories much like (very) old MS-DOS PCs. If you use it a lot, it's definitely worth replacing Windows 8's basic version.

VIRTUAL DESKTOP

A way of keeping a particular collection of windows and apps together on separate 'screens' to reduce clutter. You can flip between virtual desktops as needed.

MODERN APPS

The native Windows 8 apps that normally only run in a full screen. They're also known as Metro apps, Windows 8-style apps and Universal apps.

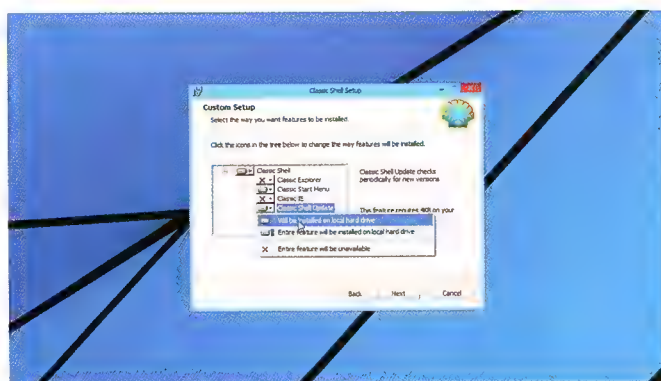


MAKE THE SWITCH

Get advanced task switching, tiled app previews and more on your Windows 7 or 8 desktop right now with Switcher 2.0.

VIRTUAL DESKTOPS

Get multiple virtual desktops and switch between them quickly using Dexpot's powerful features – before Windows 10 arrives!



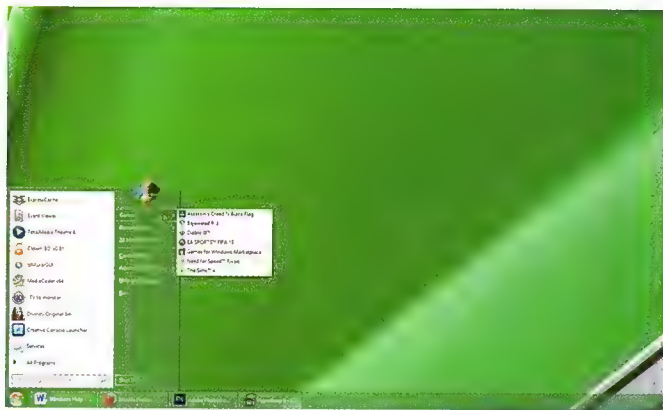
3 START WITH STYLE

Once it's installed, the next time you click the 'Start' button you'll see the Classic Shell Settings screen. First, choose which style of menu you like: 'Classic style' is more like Windows 95; 'Classic with two columns' is like the Start menu in Windows Vista; and of course 'Windows 7 style' exactly replicates the previous operating system's style. If you like, you can now click OK.



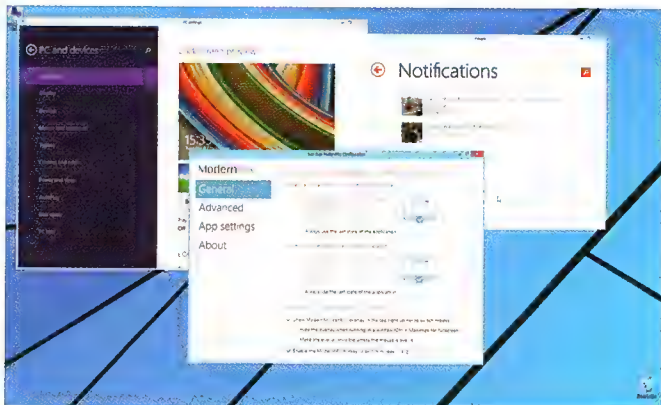
4 GOING FURTHER

There are many more ways to customise Classic Start Menu though, and it's worth having a look through all the options (just search for 'Classic' to access the settings program again). Click 'Show all settings' to display even more customisations aimed at more advanced users. You can even replace the Windows 8 Start button icon with the Start orb from Windows 7!



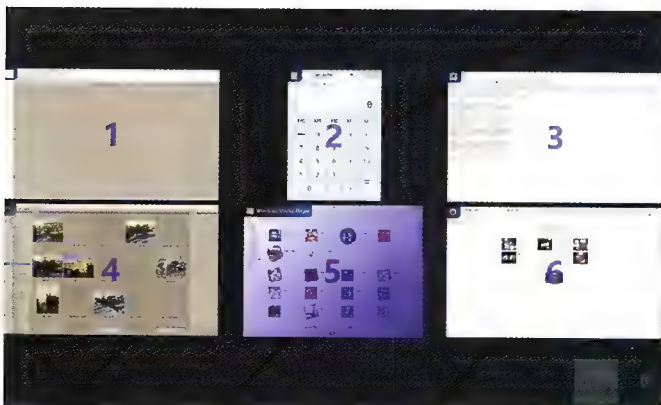
5 MODERN APPS IN A WINDOW

In Windows 10, Modern apps will be able to run in a window — unlike in Windows 8, where they can only run in full-screen mode. You can fix this with a program called ModernMix from Stardock, www.stardock.com. The full version costs US\$4.99 but you can run an unrestricted 30-day trial first when you download and install the software.



7 COMMAND CONTROL

Windows 10 includes an improved Command Prompt window that now features — at long last — proper support for copy/paste keyboard commands, among other things. You can get this right now in Windows 7 or 8 with Console2 from sourceforge.net/projects/console. It's a free standalone program that offers many extra options over the basic Windows version.



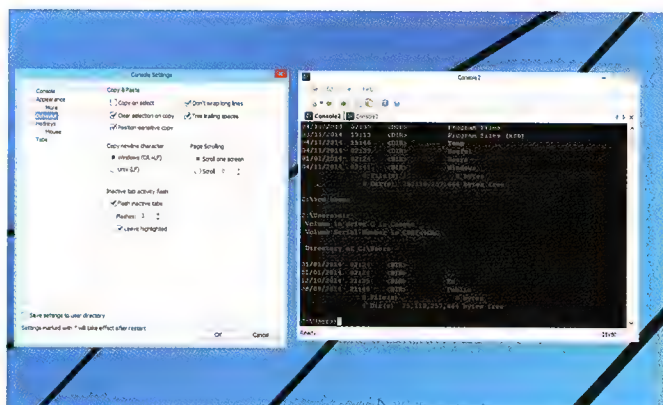
9 VIRTUAL DESKTOPS

The final major interface change in Windows 10 is virtual desktops, which enable you to group windows and apps into different sets of different 'screens'. Yet again, though, there's a well-established utility that does all this and more, which is available for Windows 7 and 8. It's called Dexpot and is free for personal use.



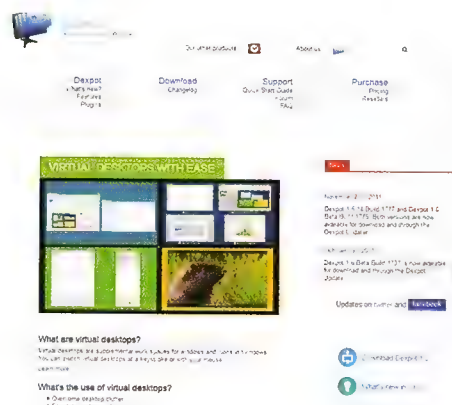
6 IN THE MIX

ModernMix can run Modern apps full-screen, in maximised windows, or in normal windows. You can change the default behaviour for apps in the General settings; by default, it assigns the F10 key as a hot-switch between each mode, or you can use the little icon that appears in the top right of the app window. Advanced settings let you tweak behaviour even further.



8 SWITCH IT ON

Task switching has been revamped in Windows 10, with a full-screen preview of all your open windows. There's a similar utility called Switcher 2.0, which runs on Windows Vista, 7 and 8. This gives you three different ways of displaying open windows, hotkeys for quickly switching between them, customisable window styles and more.



10 THE POWER OF DEXPOT

Dexpot enables you to assign apps and windows to one of four different desktops. You can assign rules so that a particular app always opens on a particular desktop, and you can preview desktops as a full-screen view, then click one to use it. There's also a handy little quick-switcher that sits near the clock, and fully customisable shortcut keys. It'll end up saving you a lot of time.

disc contents

» OUR SELECTION OF EXCLUSIVE FULL-VERSION PROGRAMS

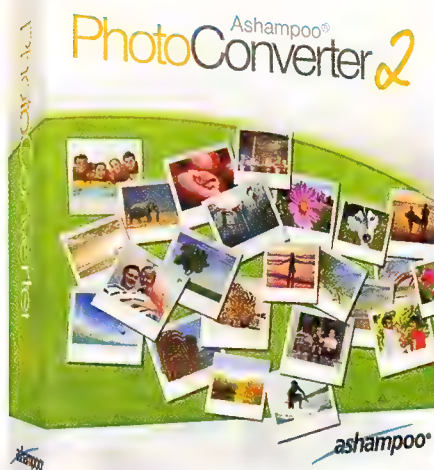
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Streamline your image admin

Process photos with
Ashampoo Photo Converter 2

FULL VERSION WORTH \$14

Ashampoo Photo Converter 2 is a Swiss army knife to process your photos. No more manual sifting through heaps of photos, Ashampoo Photo Converter 2 processes entire collections in one go, whether it be 1 or 1,000 files. Spare yourself the hassle of finetuning colours and contrasts and let Ashampoo Photo Converter 2 auto-determine the best settings for each of your images. And with "Clean Skin", compression artefacts are a thing of the past.



Protect your sensitive documents

Keep your data private
with 1-abc.net File Encrypter 7

FULL VERSION WORTH \$21

1-abc.net File Encrypter protects files of any file type with a personal password. To encrypt a file you just have to add it to your file list and click on 'Encrypt Now'. To decrypt it, you can select files the same way and click on 'Decrypt Now'. 10 symmetrical and asymmetrical encryption methods are available, and all of them can be combined with each other. Protect your private data — use 1-abc.net File Encrypter to secure your privacy!



Keep your PC running smoothly

Defrag like a pro with Abelssoft
JetDrive Pro 7

FULL VERSION WORTH \$43

JetDrive uses a highly sophisticated algorithm, providing a faster and more effective defragmentation than Windows Defrag. It features an innovative user interface design, as well as the ability to defragment single files or specific folders manually. JetDrive checks your hard disks for errors. JetDrive not only detects, but also corrects those errors.

SYSTEM REQUIREMENTS

- A DVD-ROM reader or burner.
- The APC disc is designed for use with up-to-date browsers (for example, Internet Explorer, Chrome, Firefox).
- The interface included on the APC disc requires a JavaScript-enabled browser.
- An internet connection may be required for online registration of software before use.
- The software packages on the APC disc have different system requirements. Software is included on the disc for Windows Vista, 7 and 8.

BEFORE INSTALLING

- Check the disc using a virus scanner complete with the latest antivirus data updates. The disc was checked before burning, but new viruses are being discovered all the time.
- Back up any important system and data files. It is not recommended that the software contained on these discs be installed on production machines.
- If you have any questions regarding the use of the APC disc, click the 'Help' button at the top of the screen.

USING THE DISC

- Insert the disc into a CD/DVD-ROM reader or burner and your web browser should automatically load the interface. If not, launch your web browser and load the default.html file from the root directory of the disc.

HELP

- If you have any problems with the APC disc, please visit www.apcmag.com/disc.htm.
- APC provides no technical support for this disc or any software provided on it.

NO DISC?

Please note the free cover disc is not included with digital editions or bundled promotional copies of APC.

PLUS! GOODY BADDY HEROES FULL GAME 2.5 TOP WINDOWS PROBLEM SOLVING TOOLS

DISCLAIMER Future Publishing is not the licensor of the software and documentation on the enclosed disc (the 'software'). Rather, Future is merely a distributor of the software, and your use of the software is subject to any accompanying third party licence terms. You must carefully read and comply with any such third party licence terms, together with all instructions and README files that come with the software. Accordingly, to the maximum extent permitted by law, all software is provided by Future 'as is' and without warranty either express or implied, and Future will not be liable for any damage that you may incur as a result of using the enclosed disc. You should back up any important system and data files before using the enclosed disc. We recommend that you do not use the enclosed disc on a production machine. Nothing in this disclaimer excludes any warranty that may be implied by statute, which may include the Trade Practices Act. Notwithstanding the foregoing, if the enclosed disc is faulty or damaged, we will replace them for you. While we have taken all reasonable steps to check the enclosed disc for viruses, we cannot guarantee that it is free from viruses or other harmful code and you should check each disc using a virus scanner complete with the latest antivirus updates before use.

A trio of neat Yosemite tricks

OS X 10.10 has some cool ways to work in partnership with iOS devices. Matthew JC. Powell shows you how to make them work.

For several years and several versions of both OS X and iOS, the desktop and mobile versions of Apple's operating systems have been getting closer in appearance and behaviour. While this has led some to speculate that eventually there will be One OS To Rule Them All (similar to Microsoft's approach with Windows), it actually seems kind of unlikely.

However, with Yosemite and iOS 8, Apple has introduced considerably closer integration between the two. You can use QuickTime Player on your Mac to record whatever's happening on the screen of your iPhone or iPad without any additional software

"Yeah. People do that. Go figure."

required. You can use your iPhone's mobile network access to make telephone calls from your Mac — handy if you've got a decent microphone and headphones on your Mac and hate to swap them for the comparatively tinny equivalents in your iPhone. And you can use AirDrop to shift files between your Mac and mobile devices without having to go through iTunes or even iCloud. Here's how.

RECORD THE SCREEN

There are any number of reasons you might want to make a recording of what happens on the screen of your iOS device. You might, for instance, want to incorporate a demonstration of the behaviour of an app into a presentation. Or you might want to prepare a QuickTime movie that your dad can play when he forgets how to access his voicemail instead of calling you to show him again. Or maybe you just want to record your brilliant performance in a game to show off to your friends and fans on YouTube.

Yeah. People do that. Go figure.

Anyway, whichever of these purposes you have in mind, the first thing you want to do is plug your iPhone or iPad in using a Lightning cable (this does not work with devices that connect using the older 30-pin



QuickTime Player is more than just a movie player. You can use the Screen Recording function to record the screen of your Mac, or the Movie Recording function to record the screen of an iPhone or iPad.

cables). Then start QuickTime Player.

Next, go to QuickTime Player's File menu and select 'New Movie Recording' (not 'New Screen Recording' which is only for recording the screen of your Mac). A new window will appear showing whatever is visible through your Mac's default video input source.

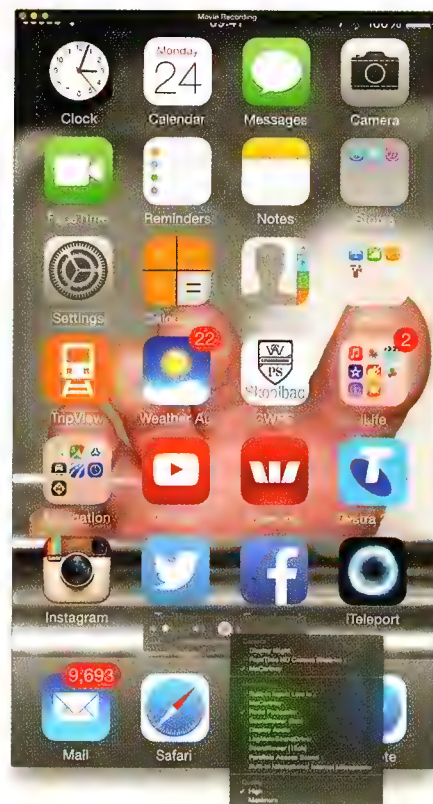
Next to the record button in that window, you'll see a small downward-pointing arrow. Click on that to show the list of available input sources. One of them will be the name of your iOS device (in this case it's 'McCartney'). Note that you can choose both a video and an audio source for input — if you want to record the visuals of a game, for example, but add insightful narration with an external microphone.

Click on the record button, and whatever happens on your iPhone or iPad will be recorded on your Mac.

MAKE A CALL

You can already make voice calls using your Mac via the miracle of FaceTime Audio, but of course that only works if the person you're calling is also using FaceTime. If your contacts use non-Apple phones or even — shudder — landlines, FaceTime Audio won't reach them.

If, however, you have a Mac running



To record what happens on the screen of your iPhone or iPad, select it as the video input device from the drop-down list. Note that you can choose to record audio from your iOS device or a different source.

Yosemite and an iPhone running iOS 8 on the same WiFi network, that barrier no longer exists. (Note that the phone doesn't have to be plugged into your Mac, or even in the same room.)

Start up FaceTime on your Mac, and click on the Audio tab. Then type a contact's name or phone number into the search field. You can also type phone numbers of people who aren't in your Contacts list.

Then click on the telephone icon to the right of the name or number. If it's a number that has been registered with FaceTime, you'll have the option to make a FaceTime Audio call or to make the call using your iPhone. If it's not a number that's been registered with FaceTime on anyone's device, you'll only have the iPhone option.

Incidentally, this newfound integration between your Mac and your iPhone also extends to SMS messages. If you check your Mac's



The widescreen experience. The movie you make will match the orientation of your iPhone.

Messages app, you'll notice you can now send SMS from your Mac (with its full-size keyboard) to phones that do not support iMessage.

SHIFT FILES

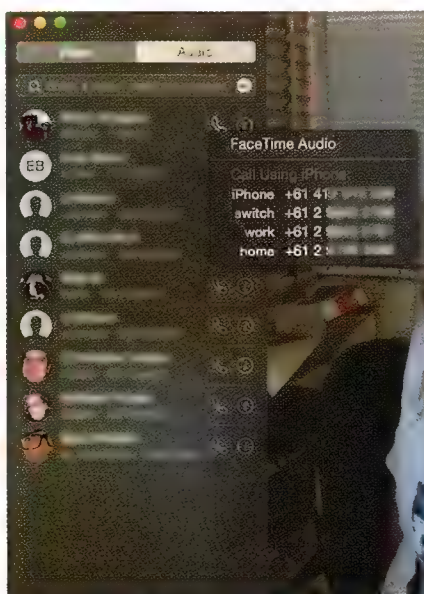
The convoluted steps necessary to shift files between Macs and iOS devices have been many a user's bugbear since the earliest days of the iPhone. The number of third-party apps on the App Store designed to perform that very task are testament to it.

For some time Apple has offered AirDrop as a simple way to share files between Macs and, more recently, between iOS devices. However, if you have a Mac built in 2012 or later, Yosemite and iOS 8 can swap files with each other just as conveniently.

On your iOS device, swipe up from the bottom of the screen to access Control Center, then tap on the AirDrop icon. Choose whether you want to share files with Everyone or Contacts Only. Either will do for sharing files between your iOS device and your Mac since, obviously, you are in your own Contacts list.

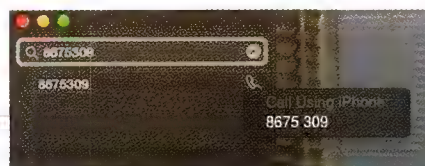
On the Mac, open a Finder window and click on AirDrop in the sidebar. If you have a recent enough Mac, you'll see blue text at the bottom of the window that reads "Allow me to be discovered by ...". Click on it, and you'll have the same options as you had on iOS. (If you don't see that text, your Mac does not have the requisite hardware to support this.)

To copy a file from the Mac to the iOS device, simply drag it onto the icon in the AirDrop window corresponding to

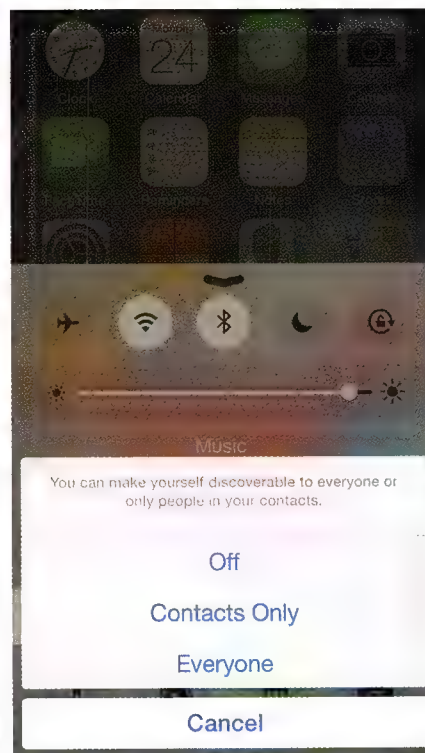


If you're trying to call someone in your Contacts list who has FaceTime available, you can decide to call them using FaceTime or using your iPhone's mobile network.

that device. You'll get an alert on the device allowing you to choose whether or not to accept it. To copy a file from the iOS device to the Mac, tap on the Action icon (little square with an arrow coming out of it) and your Mac should appear among devices available for AirDrop sharing. Note that even though AirDrop operates over WiFi, it uses Bluetooth for authentication – so your Mac and iOS device must be within Bluetooth range (about nine metres). ■



Contrary to what you may have heard, this trick even works with numbers that are not in your Contacts list.



On your iOS device, use Control Center to determine how widely you wish to share. Note that sharing with "Everyone" could potentially be a security hazard.

Access an iOS device from your PC

Back-up, transfer and delete iPad and iPhone files from your PC or Mac with Nick Peers.

While you can get some access to the files stored on your iPad or iPhone through iTunes, this is fairly limited. The good news is there are apps available that give you access to all of the files and folders on your iOS device without needing to jailbreak it. This gives you complete control over what goes on (and comes off) your mobile device. We'll look at one of them here: iFunBox, which is free from i-funbox.com. It's also available for Windows, but for this tutorial we've largely stuck to the Mac version.

Once installed, iFunBox lets you

browse your iPad, iPhone or iPod touch storage through a Finder-like interface. By placing your apps, media and other files at your fingertips, you can clear much-needed space without uninstalling apps, as well as back up or transfer documents, files and apps from one iOS device to another via your Mac without a Wi-Fi connection. You can even turn part of your device's unused capacity into spare storage, just like a flash drive.

If you plan to use iFunBox to clear space, it warns you to be careful with the data you decide to delete — there's no going back unless you've backed it up to your PC or Mac first!

1 NAVIGATION

Use this pane to drill down through your iPad or iPhone's file system — if you're struggling to find what you're looking for, select 'Raw File System' for more places to look.

2 SWITCH VIEW

To see how much space files are taking up on your device, switch to the list view by clicking here. Choose icon view when you want to see previews.

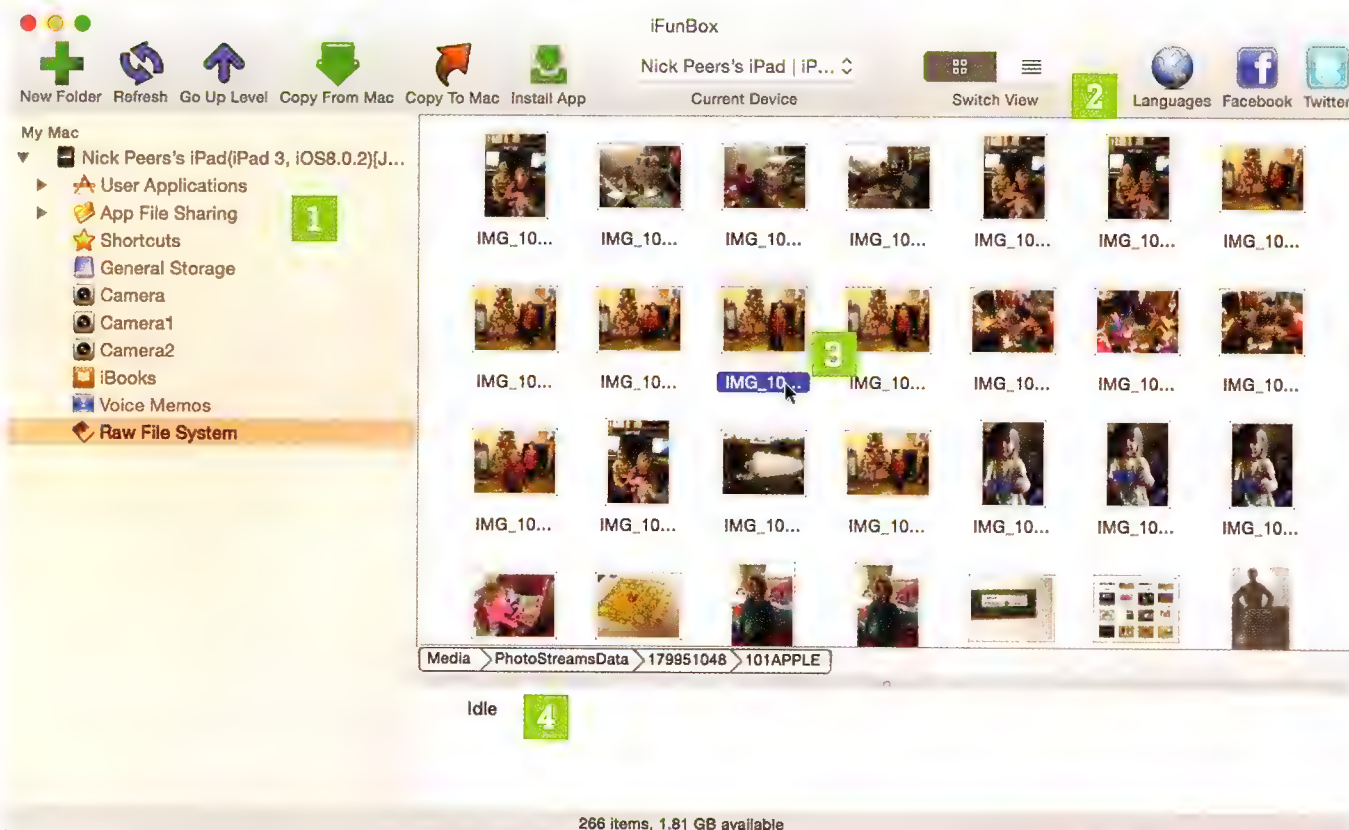
3 VIEW AND SELECT

The contents of the currently selected folder are displayed here. You can drag files from here onto your Mac desktop, plus copy files from your Mac to your iOS device if you like.

4 BREADCRUMBS

Want to jump up a folder level or two? Click on the folder name here to quickly move to a previous folder you opened.

"You can even turn part of your device's unused capacity into spare storage, just like a flash drive."



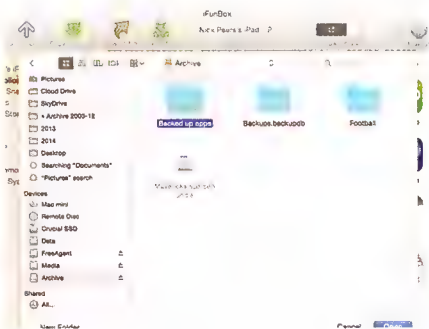
How to Browse, clean up space and manage apps



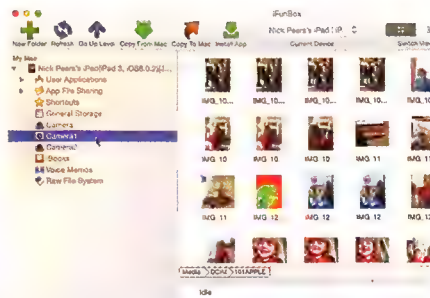
1 GET CONNECTED
Once installed, plug in your iOS device(s) via USB and wait for iTunes to open and sync, then open iFunBox. If you have more than one device connected, select the one you want.



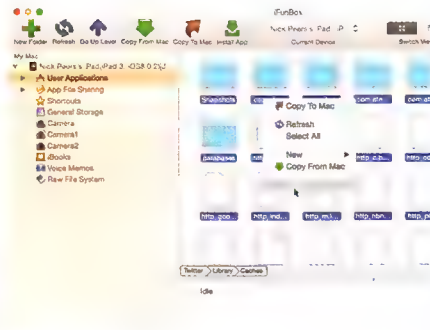
4 FREE UP SPACE
One of the best ways to free up space is to empty app caches. Tap Settings on your iOS device and select 'General > Usage > Manage Storage'. Now tap an app to see how much its Documents & Data uses. If it's a lot, add to the clean-up list.



7 BACK UP APPS
You can back up the latest version of any app to your choice of folder on any drive, for back-up purposes or to transfer it to another iOS device. Right-click the app under User Applications and choose 'Backup to .ipa package > Without Personal Data'.



2 BROWSE YOUR DEVICE
You'll see a dual-paneled window giving you access to just about any part of your iOS device's storage. See left for how to navigate using the various tools as well as preview and open individual files.



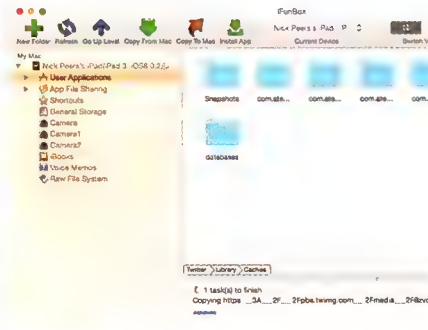
5 LOCATE CACHES
In iFunBox, double-click the app icon under User Applications. Open the Library folder where you'll find a Caches folder. Drag this to your desktop to back it up, then open the folder and select all. Right-click on a file and choose Delete.



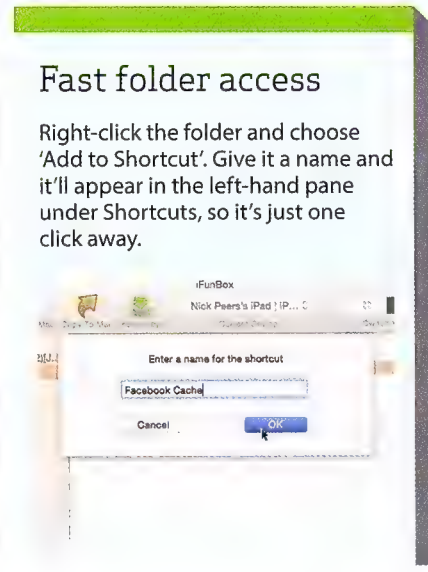
8 MANAGE YOUR APPS
Click the Install App button to install an app from an .ipa package — either one you backed up, or through iTunes ('Music > iTunes > iTunes Media > Mobile Application'). Remove multiple apps by Command-clicking them in turn, then right-clicking and Uninstall.



3 TRANSFER TO YOUR MAC
When you've found the files you want to copy, select them in the usual way. Once selected, either drag them on to your desktop to quickly copy them, or click the Copy to Mac button.



6 TEST APP
Return to 'Settings > General > Usage > Manage Storage'. Your app no longer consumes as much space. Try opening the app — if it launches normally, move on to the next one; if not, open the Caches folder and drag everything back to restore it.



Construct a 6-core Haswell-E rig

Tom McNamara links Intel's six-core Haswell-E with a pair of GTX 980 cards and discover that when in doubt, add more power.

As much as we like doing exotic things like dunking computer parts in mineral oil or cramming them into a case the size of a cigar box, it's also good to return to our roots and do some more conventional systems. But since this is still APC, we're not going to just sweep up some leftover bits and slap them together. We try to be educational as well. We want to simulate choices that more sane people would undertake. And we know that when you open up the pages of this magazine, one of your purposes is market research. "Should I buy X, or Y, or should I wait for Z to come out?"

So that's why we're assembling something nice and fancy, but not too weird to live. We're taking Intel's 6-core Haswell-E CPU for a spin and testing it with two GeForce GTX 980 video cards, a premium 1TB SSD, and a full-tower case. And along the way, we got a little educated ourselves.

OF MICE AND MECH

Nvidia's GTX 980 cards were at the top of the heap as this issue went to press (though AMD's Mantle API has been making some impressive inroads).

We've tested it before, but we haven't used it in a multcard build until now. They're still a bit difficult to find due to their popularity, but Nvidia sent us an extra one to work with. It's the reference version instead of the kind with the fancy cooling, but we can hardly complain. The reference model uses the blower style cooling design that the company introduced with the GTX 780 in May 2013. It can't overclock as high as cards with third-party cooling, but it has certain other advantages that we'll get into later.

Intel's Core i7-5820K CPU is the beating heart of this machine, sitting on top of a Gigabyte GA-X99-UD4 motherboard and cooled by an NZXT Kraken X61. The 5820K has six CPU cores and 12 threads, and it has 28 PCIe lanes available, compared to 16 lanes for the LGA 1150 platform used by regular Haswell chips such as the i7-4770K. This 2011-3 mobo also requires DDR4, which is more expensive but also faster. For storage, we dropped in a 1TB Samsung 850 Pro SSD. It's a premium part, but we wanted to have a little fun. Powering everything is a "gold" 730w Enermax Revolution XT. And the case is a Corsair Obsidian 750D.



This is a 2011-3 mobo, so you get a whopping eight RAM slots. The chip works best when its RAM is in sets of four.



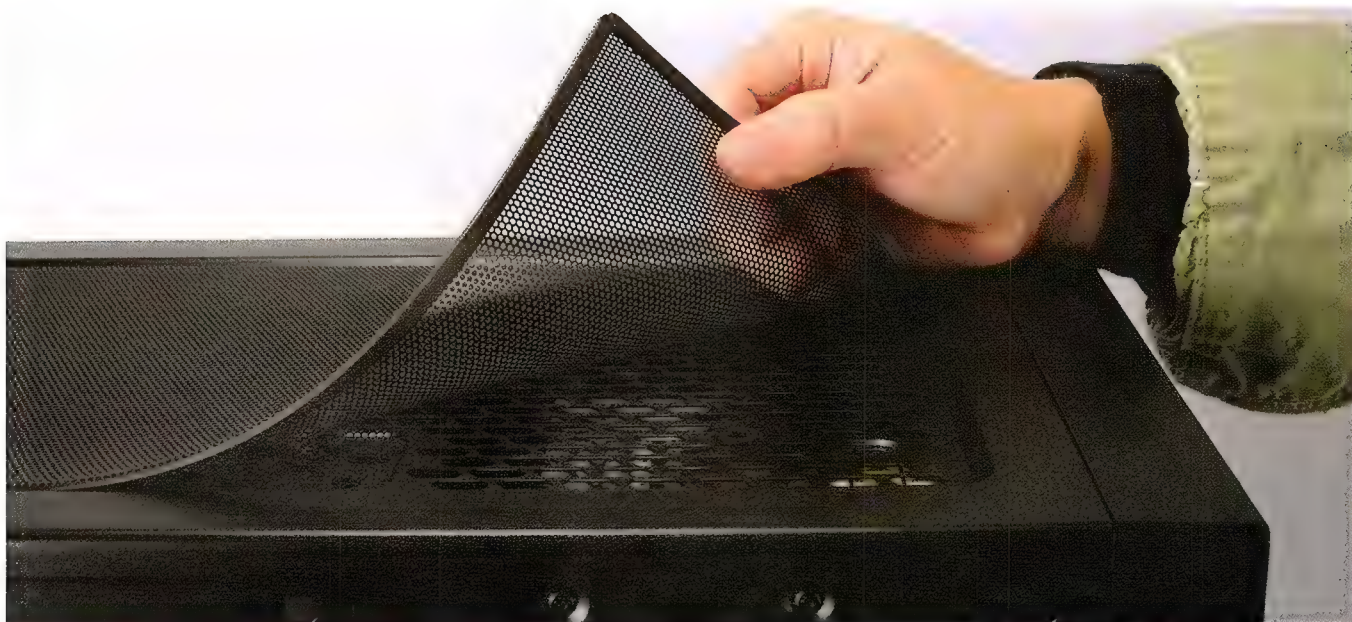
PARTS

	PART	PRICE
CASE	CORSAIR OBSIDIAN 750D	\$199
PSU	ENERMAX REVOLUTION XT 730W	\$135
MOBO	GIGABYTE GA-X99-UD4	\$379
CPU	INTEL CORE I7-5820K	\$479
CPU COOLER	NZXT KRAKEN X61	\$159
GPU	2X NVIDIA GEFORCE GTX 980	\$1,558
RAM	4X 4GB CORSAIR VENGEANCE LPX DDR4/2133	\$380
HDD	3TB SEAGATE BARRACUDA	\$129
SSD	1TB SAMSUNG 850 PRO	\$729
CABLE	3-PIN FAN EXTENSION	\$3
OS	WINDOWS 8.1	\$120
TOTAL		\$4,270

GETTING ON BOARD

Compared to Intel's previous X79 platform, the biggest deal with X99 is arguably the addition of two extra CPU cores. The 5820K has six, whereas the 4820K had four. At the top end, the 5960X has eight, whereas the 4960X had six. The upshot? More heat generation.

Intel tends to improve this aspect from one generation to the next, but it's



hard to absorb the addition of this much horsepower. That means we want a beefier CPU cooler than usual. That's where NZXT's Kraken X61 comes in. This cooler has a 280mm radiator, whereas the upper range usually sits at 240mm. The extra surface area dissipates heat faster (and these 140mm fans are quieter, too).

FULL FRONTAL

The front of the case is also worth a gander. The aluminum face has two upper corners, just below the lowest 5.25-inch drive, that you press to release the front bezel. That reveals another removable fan filter, behind which are two pre-installed 140mm intake fans. However, their cables aren't very long. If your motherboard doesn't have fan headers on the near side, you'll need an extension cable, a Molex adapter to plug the fans directly into the power supply, or a fan controller installed in one of the 5.25-inch drive bays. We used an extension, which you can get from Newegg or Amazon for a few dollars.

BOTTOM'S UP

Finally, the bottom of the case. This is interesting because there's not one but two 140mm fan mounts down here. Since they're adjacent, you could stick a second 280mm radiator down here, if you wanted. Why would you want to? Well, if you're doing full-fledged liquid cooling, two 280mm radiators in a case (one on top, one on bottom) is not a bad start. Some gearheads also modify their video cards to add a closed-loop liquid cooler, making this a convenient location to mount the radiator. The mount closest to the front of the case isn't immediately accessible, though, because there's a drive cage there. However, this cage can be installed right under the 5.25-inch drive bay to



The power supply is modular, so cables can detach from here if you don't need them. This reduces case clutter.

clear the way. To the left of the fan mounts is yet another removable air filter, this time for the intake fan on your power supply.

FOUR MORE TO STORE

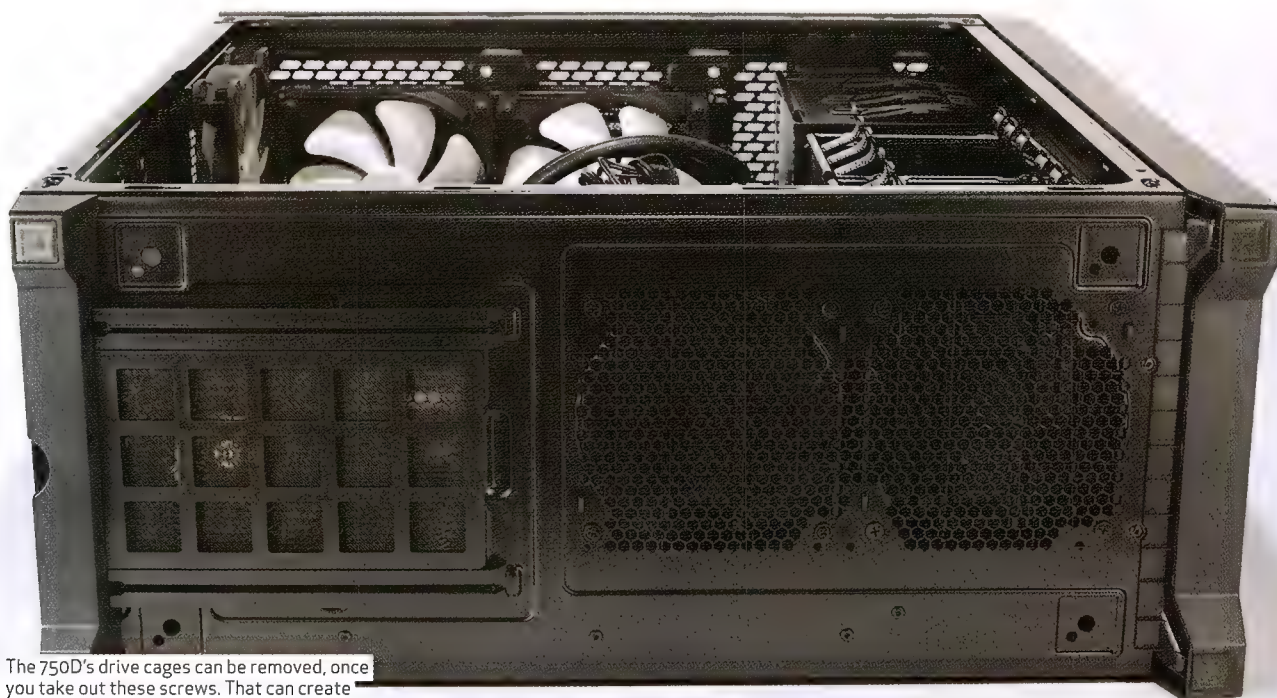
If you only have 2.5-inch drives, you can remove the 3.5-inch cages altogether. So much room for activities! We chose to use the cages so that you could see the conventional look, with one mechanical drive in one cage and one SSD in the other. But the Corsair 750D case also has four of these brackets on the other side of the drive cages. These brackets snap in and out, and they can each hold one 2.5-inch drive — no screws required. (Each

bracket has two screw holes, but they're not really necessary, since the fit is quite snug.) Since you can get 1TB SSDs and 2TB 7,200rpm drives, there's a lot of storage that you could cram in here without taking up much space inside the case.

The Gigabyte motherboard itself also has an M.2 slot for more low-profile solid-state action. Since this is a full-tower case, there's enough space behind the motherboard to wrangle SATA and power cables in this section.

FEELING ELECTRIC

With two video cards in play, a couple of storage devices, and a CPU cooler that uses a SATA power connector,



The 750D's drive cages can be removed, once you take out these screws. That can create room for things like reservoirs and pumps.

LABS BENCHMARK RESULTS

Our current desktop test bed consists of a hexa-core 3.2GHz Core i7-3930K, 16GB of Corsair DDR3/1600, on an ASUS Sabertooth X79.

PREMIERE PRO C56	OVERALL SCORE (SEC)
APC LABS TEST RIG	2,000
HASWELL-E PC	1,582

0 1000 1500 2000 2500 3000

STITCHFX 2.0	OVERALL SCORE (SEC)
APC LABS TEST RIG	831
HASWELL-E PC	754

0 200 400 600 800 1000

PROSHOW PRODUCER 5.0	OVERALL SCORE (SEC)
APC LABS TEST RIG	1,446
HASWELL-E PC	1,452

0 500 1,000 1,500 2,000 2,500

X264 HD 5.0	OVERALL SCORE (FPS)
APC LABS TEST RIG	21.1
HASWELL-E PC	26.9

0 05 10 15 20 25

BATMAN ARKHAM CITY	OVERALL SCORE (FPS)
APC LABS TEST RIG	76
HASWELL-E PC	141

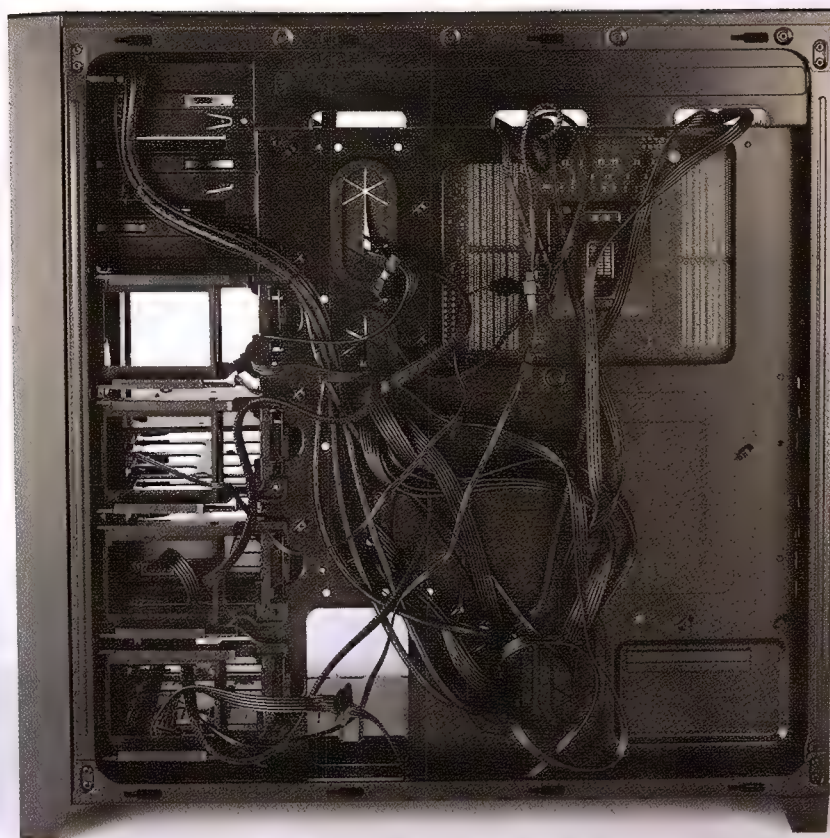
0 50 100 150 200 250

3DMARK 11	OVERALL SCORE
APC LABS TEST RIG	5,847
HASWELL-E PC	10,627

0 2,000 4,000 6,000 8,000 10,000

there's a lot of cables. The Enermax Revolution XT is a modular power supply, but we added the Molex cable so you can see how messy things could get. You might also wonder why we went with a modest 730 watts. It turns out the GTX 980 cards have a TDP of just 165 watts. In total, this system will





use less than 600 watts before OCing. But we can see an argument for beefing it up, so we'd probably upgrade to an 850-watt XFX ProSeries or a SeaSonic X-850. You could save cash with a Radeon R9 290 or 290X, but a Crossfire build would demand an upgrade to 850 watts, since those cards have TDPs of about 250 and 290 watts, respectively.

SHAKEN, NOT STIRRED

Whenever you wrestle with a new mobo chipset, expect to get bumped and bruised. At first, we had serious issues with stability. Was something loose? Was there a short circuit? We went the conventional route of removing everything not required to boot Windows, stripping down to one stick of RAM, one storage device, and one video card. Still no luck. We installed Intel's chipset drivers and management engine, and that didn't fix it. We looked up the mobo on Gigabyte's web site and noted there was a BIOS update to fix crashes when things were plugged into the board's front USB headers. We unplugged the devices we'd connected there, and still no dice. It wasn't until we updated the board to the latest BIOS (version F9C) that our issues went away.

As advertised, the Kraken X61 CPU cooler was able to keep this six-core chip's temperatures under control without getting too noisy, despite us overclocking to 4.3GHz on all cores. The i7-5820K has a default clock of 3.3GHz and a "turbo boost" of 3.6GHz, but the boost only applies to two cores. The other four cores run at up to 3.4GHz. So pushing that up to 4.3GHz on all six is a pretty respectable upgrade.

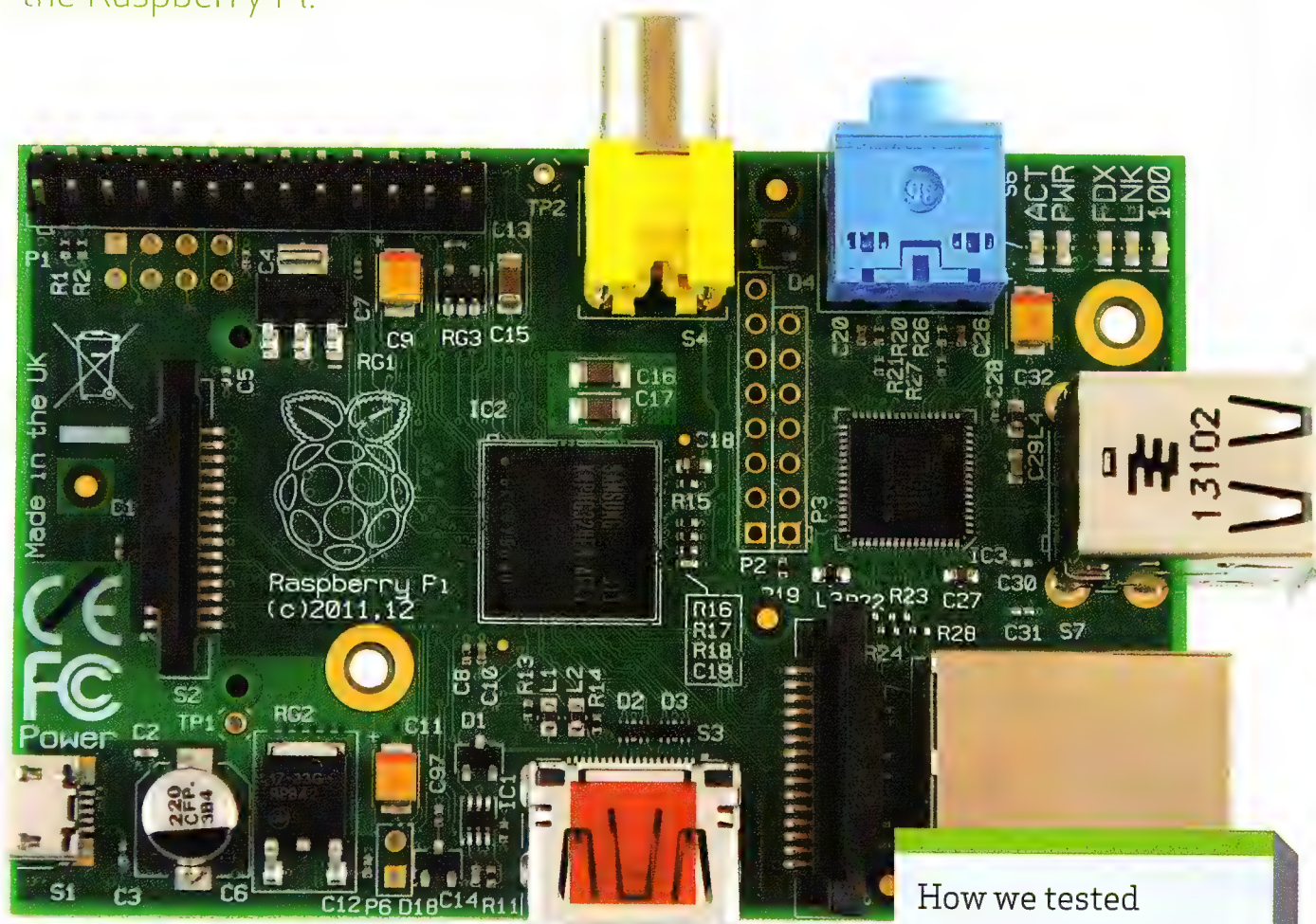
These video cards, on the other hand, won't meaningfully benefit from overclocks. That's because these reference versions already hit the card's thermal limit of about 81 C. Increasing clock speeds ups heat, so a GPU overclock here basically won't have an effect. On the flip side, these cards have "closed" shrouds, so all the air moved around by the video card's fan will get pushed out the back of the case—as does a lot of the heat. Some will still rise off the top of the cards, but our stock 140mm exhaust fan is more than up to the task.

Overall, this felt a solid build, once we'd fixed the crashiness. The i7-5820K is quite a workhorse for the price (though we had some oddness with ProShow), dual GTX 980s crush benchmarks, and the 750D case has a lot of expansion room for extra storage, cooling, and video cards. But if we did it again, we'd go with a larger power supply, just to be safe. ■



Raspberry Pi OS face off

Let's take a look at a sweet selection of tasty operating systems for the Raspberry Pi.



How we tested

The Raspberry Pi comes in two major flavours these days: the original 'B' model version 1, which has 256MB of memory, and the much newer model 'B' version 2, which now comes with 512MB.

Therefore, to get a true all-round perspective, we took the time to install the operating systems on a 4GB SD card on both the new 512MB, and the older 256MB model Bs. The areas we're looking at are installation, default software, media playback (out-of-the-box), looks and usability, the community behind the OS and their respective attitudes toward software freedom. Basically, the very stuff that makes a Linux user decide on what system to use.

We also want to gauge this from the point of view of someone who's not as familiar with Linux as other people are, so that they can jump into the project without too much hassle, and not end up leaving it feeling disheartened.

The Raspberry Pi phenomenon appears to go from strength to strength; like a runaway train, it's ploughing ahead and forging itself a place in the record books. It's hardly surprising – the hardware alone is developed perfectly for the goals of the Raspberry Pi Foundation, the pricing is pitched perfectly, and having the unique versatility of Linux as the operating system seals the deal nicely.

Most buyers, once they get their hands on their new RPi, make a move towards the official Raspberry Pi site and follow the getting started

instructions therein; the end result is the user running Raspbian 'Wheezy', the Foundation's recommended operating system, creating, learning and programming, and strapping the poor wee beast on to a weather balloon and sending it to the outer edge of the atmosphere. What many RPi users don't realise, though, is that there's a wealth of other operating systems available for their beloved Pi.

We thought, therefore, that those users who aren't aware of these other sweet toppings for the Raspberry Pi need to be informed, and what's more, they need to have a chocolate box selection presented to them.

"What many RPi users don't realise, though, is that there's a wealth of other OSs available for their beloved Pi."

INSTALLATION

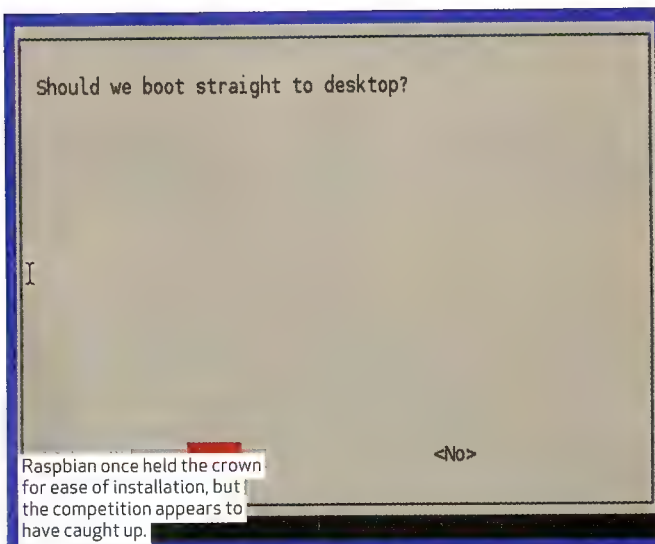
Do you need a PhD to install the OS?

The installation of an OS image is fairly well documented, as per the area on the Raspberry Pi site titled 'Guide for beginners', elinux.org/RPi_Easy_SD_Card_Setup, along with the simple installation routine of using either dd on Linux, or Win32DiskImager on Windows, to transfer the image to the SD card. The process is fairly painless, it's what happens after you insert the SD into Raspberry Pi and apply some power that the fun starts.

The five operating systems we tested – Raspbian, Risc OS, Arch, Android 2.3 and Plan 9 – each have their own nuances, and methods by which to install and provide the user with a base working graphical desktop. While having a GUI isn't absolutely necessary, it does cover the large percentage of users who are new to Linux. That being the case, the definition of 'installation' must include getting to the point whereby the new user

can recognise the operating system as they would a standard Linux desktop – in other words, be presented with a graphical user interface. In a world where easing the user into the bath water of Linux is paramount, Raspbian did once sit atop the first-place podium, but the other offerings have just as good a start for the user. Take Risc OS, for example; once transferred to the SD card and booted, we are rapidly launched into a colourful and friendly GUI, with relatively detailed messages informing us of any issues during the initial boot and setup. From here, we can simply click on the Configure icon and begin to alter any settings we see fit.

Arch Linux for the RPi is a different beast, booting the user into a terminal environment and leaving them to download, install and configure their OS. Arch, once fully appreciated, is one of the best operating systems available, but it



takes some tweaking to get to the normalised desktop.

The current Android for the RPi project is beginning to shape up; when booted, you'll be presented with the official Android unlock screen, and behind that the interface we all know and (sometimes) love. It's still a little buggy, crashes a fair bit and is extremely slow, almost to the point of being unusable on the 256MB RPi's – 512MB versions fair slightly better.

Plan 9 delivers a GUI that's effective, but has a steeper learning curve, although it's well documented. Raspbian offers a text-based menu on

boot. Users can configure the system, enable SSH and boot automatically into the user-friendly LXDE GUI.

We would recommend Raspbian for the beginner, followed by Risc OS, and Arch as they become more familiar with Linux and its workings.

Verdict

Raspbian	★★★★★
Risc	★★★★★
Plan 9	★★★★
Android	★★★★
Arch	★★★

Raspbian brings the user to a familiar desktop GUI – it's easy to use.

DEFAULT SOFTWARE

What's in the box for the sweet-toothed Pi user?

The software that you get for each Raspberry Pi OS varies greatly, but what you do get out-of-the-box can often be the single biggest selling point for the system.

We shouldn't expect anything too complex, though, after all this is an OS running from an SD card and being delivered by a credit card-sized computer with minimal resources available.

While the likes of an office product and full multimedia and graphics editing packages are the norm on a standard distro, we were quite pleased with what we got from our selection of RPi operating systems.

Raspbian leads the way, with default software – as would be expected – but Risc

OS isn't too far behind, and incidentally, if you opt for an additional payment for the NutPi Pack, then you'll be offered a fully-working Raspberry Pi desktop, complete with office software, internet browsers, messaging and so on.

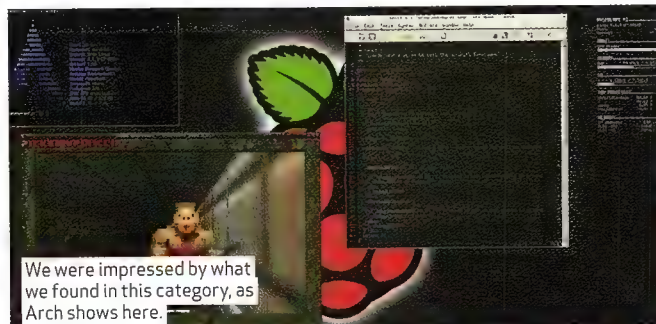
Arch, as mentioned, brings you to the terminal, but if

you know your terminal commands, you'll be able to achieve a result that's almost the same as the desktop. However, matching Raspbian takes us out of the default software realm.

Android was the surprise here, with a decent selection of media-ready software, but no office-based apps. For

some reason, we expected the RPi Android project to be devoid of apps, so we were quite shocked to see the usual suspects present.

Plan 9, however, was quite bleak. Once we broke through the desktop environment, Rio, we found little to work with effectively – especially so for the newcomer.



Verdict

Raspbian	★★★★★
Risc	★★★★★
Plan 9	★★★★
Android	★★★★
Arch	★★★

If you pay for the NutPi Pack, then you won't go wrong with Risc OS.

LOOKS AND USABILITY

Looks and usability aren't everything. Oh yes they are!

Desktop eye-candy remains something of a guilty pleasure for most Linux users. Despite convincing the world that the operating system is a lean and mean machine, the user then goes and installs 3D rotating desktop objects, on-screen fire, Conky-esque dials and all manner of glitz and glam. It's a personal thing, and regardless of the toll taken on the resources, we like a bit of glitz on our desktops. Of course, there comes a point whereby nice graphical desktops forsake the usability of the system – remember Vista, anyone? So while each of these RPi operating systems has the potential to be drop-dead gorgeous, there's a trade-off due to the low resources the RPi has available.

Looking at each of the OSs from humble beginnings to what can be achieved with a little work, we're sure you'll find a nice compromise with the selection offered.

Raspbian ★★★★★

From the outset, Raspbian gives the user a bland but functional desktop. Using Xfce as the desktop environment means the RPi's resources are kept well in hand, and not wasted on inefficient eye-candy. However, Raspbian, being a Debian-based distro, means that the desktop can be altered to significant effect.

The likes of Mate for Raspbian can be installed, giving the desktop the same look and feel as a classic Gnome 2 environment, which means you can then go forth and tweak it to your heart's content.

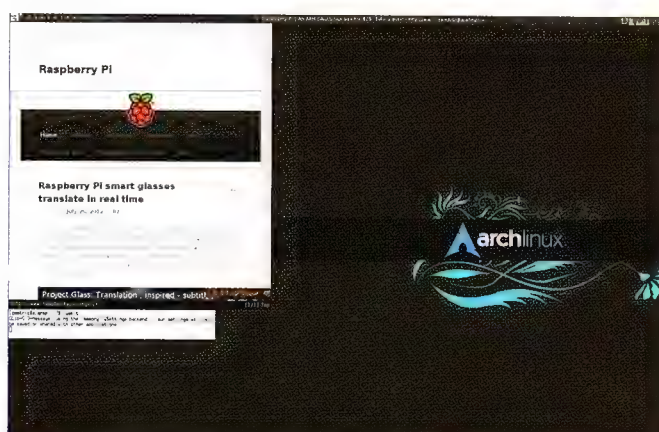
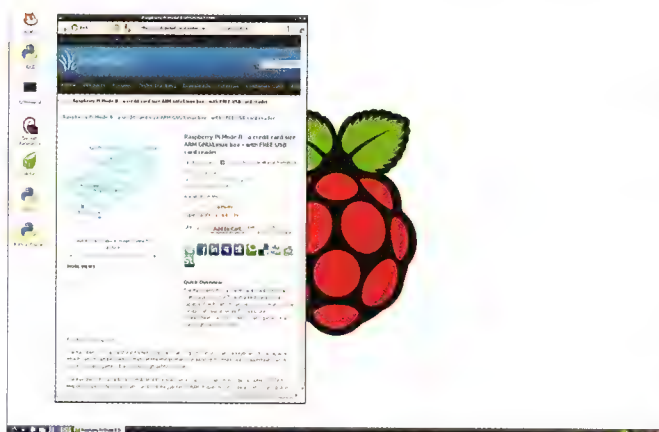
In terms of usability, Raspbian flies ahead of the pack initially, but a trigger-happy user may get carried away with the apt command, install hundreds of programs and make the OS start to feel like a pig in treacle.

Arch ★★★★★

Arch is a funny one. It starts life on the RPi, displaying nothing more than the terminal; but if you take the time to delve into it, you'll come across one of the best operating systems there is.

Arch, by its very nature, is a streamlined OS, and even after installing a desktop environment such as OpenBox, the system responds quickly. In terms of looks, if you combine OpenBox with a Raspberry Pi theme and Conky, you're well on the way to a very pleasing desktop.

Again, as with the looks side of things, Arch's usability is all down to what you want to install, which makes Arch – eventually – the most configurable and usable OS. A few installed packages, and you'll have Arch running like a charm and running rings around its bigger, fatter brother, Raspbian.



THE COMMUNITY

Like Gotham, but without the violence, affairs, deaths...

If there's one thing that makes Linux stand out as the OS of the people, it's the community. Made up of individuals who are willing to help, share and promote their favourite OS, the Linux community is a place where the new can learn, and the experienced can pass on their knowledge. There's also a significant number of trolls and idiots, but you get them in every walk of life.

Raspbian and Arch have the biggest communities. Raspbian especially, as the

prime focus of the forum on the Raspberry Pi site is dedicated to the working of Raspbian. Arch, though, has a following that almost rivals it – and it's growing, as the user base comes to terms with different OSs for RPi.

The Raspberry Pi Android project is gathering pace, with more and more users beginning to look at the potential of the port to the RPi, but it's a little bleak at present. Risc OS, which has a following of users from

many years back, hosts a vibrant community. Plan 9 for the RPi may be newer, but its followers have detailed and documented many help files online since its initial release way back in 1992.

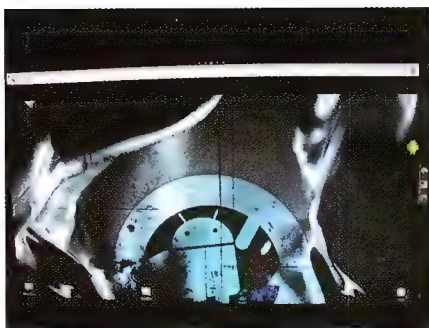
Most of the community offerings can be found on the respective OS sites, but take the time to browse through the Raspberry Pi forum to find what you're looking for; if you are stuck, don't be afraid to ask – the users on the RPi forum are

a good bunch, and are often more than willing to help out a newcomer or more advanced user.

Verdict

Raspbian	★★★★★
Risc	★★★★★
Plan	★★★★★
Android	★★★★★
Arch	★★★★★

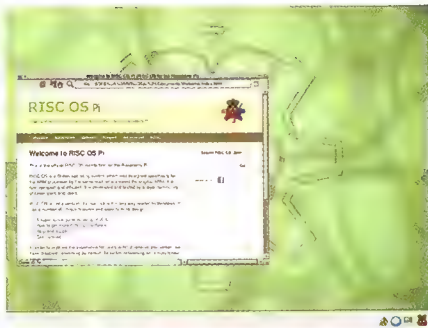
The Linux community is a resource we should use and encourage.



Android ★★★★★

Android 2.3 in itself is a pretty good-looking operating system. Decent animations, high-spec icons, themes, animated wallpapers and desktops make for an eye-catching environment. When used on the Raspberry Pi, though, things tend to go a little awry.

The current Android project for the RPi is far from perfect, but it's a project that will be completed, and one that will eventually outshine the others — we're just not sure when exactly. In its current guise, working on the 256MB RPi, it's borderline unusable, but the increased RAM of the 512MB RPi can make things a tad better. It's still not something you could use day-to-day, but keep an eye on the project, because it'll soon come to the forefront of RPi news.

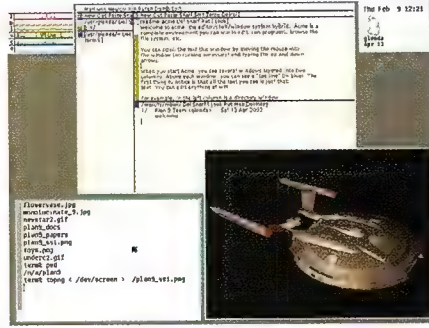


Risc OS ★★★★★

Risc OS, like Raspbian, takes you into a nice GUI at startup. The Risc OS GUI is a well laid out and colourful environment; it's also a nice change to have an environment boot to 1080, providing your monitor can cope with that resolution.

In terms of looks, the base desktop is probably all you'll ever need; it resembles the glorious past that Risc revels in, making it feel a little retro, but not in a poor-quality, 8-bit kind of way.

In the usability stakes, Risc OS starts off a little niche, requiring some experience to get off the ground. For example, the Ethernet port is disabled by default — there are full instructions on how to enable it, but doing so could put off a newcomer. However, perseverance, as with most aspects of computing, is the key and we can guarantee that within an hour of first use, you'll be navigating Risc OS like a pro.



Plan 9 ★★★★★

If you've used Windows, Mac OS X, Linux or even Unix, then forget everything you thought you ever knew when using Plan 9. Although the commands are familiar, getting to them is something of a task. Unfortunately, the level of understanding here represents a rather steep learning curve, which makes it a little awkward to get off the ground; but there is plenty of documentation out there.

Rio, the Plan 9 windowing system, looks and feels like a step back to the old Amiga and Atari ST days, because the façade is nearly the same. It does take some getting used to, and it's quite easy to become overwhelmed by the sheer amount of reading material, but as we've stated many times already, keep going and you'll soon discover a rather pleasing desktop that's simple and elegant, and flies at a rate of knots.

SUITABILITY FOR CHILDREN

How user-friendly are they?

The Raspberry Pi has, as we all know, endeared itself to the next generation of computing wizards, but how usable is our selection of

operating systems?

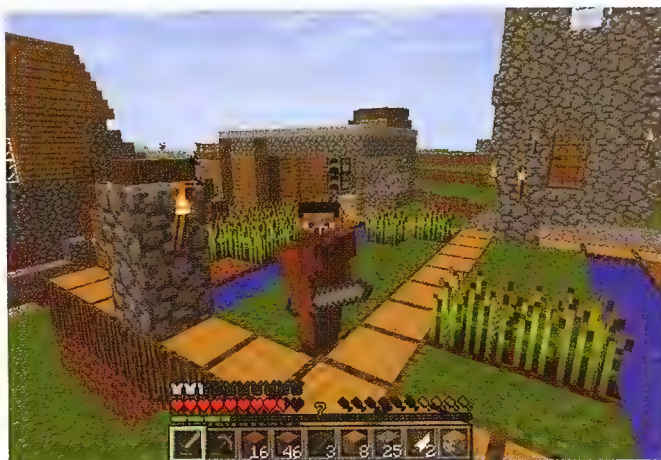
It's all fine and well offering the next generation the tools to become more experimental with

computing, but if the task of getting the hardware talking to the user in a human way becomes too difficult, then those users could well leave the project and never return.

In this instance, we're targeting the younger generation, and how they will cope with the OSs on test. For this, we recruited an 11-year-old and a 10-year-old, Daniel and Hannah, to set up the operating systems for us.

Raspbian and Risc OS came out on top, being easy to get up and running and use. Android left a bad taste in their mouths, as did poor old Plan 9. Arch drew blank looks that brightened up

after a bit of work. In the words of Daniel, "Raspbian rules!" whereas Hannah enjoyed the look and feel of Risc OS: "Risc OS looks much nicer." There we have it. The youth of today have spoken!



Verdict

Raspbian	★★★★★
Risc	★★★★★
Plan 9	★★★☆☆
Android	★★★☆☆
Arch	★★★☆☆

The kids like Raspbian and Risc OS, and a big bag of Haribo!

MEDIA PLAYBACK

Having a tiny media centre is OK, but does it play from the word go?

Media playback is contentious in Linux. Some distros provide the latest codecs and software, others don't. The beauty is you are free to download and install your preferred player, and tweak it to your needs. But how will our OSs cope with media out-of-the-box?

Android was the surprise OS, with a decent playback of our HD movie. Unfortunately, playback stopped two minutes in and refused to go any further on the 256MB RPi. Amazingly, this occurred to the point whereby we had to re-image the SD card because Android refused to boot. The 512MB version fared better, but the video stopped after 15 minutes. The video was viewable, although during camera panning there were cuts and tears, but we

figured that to be the limits of the default state of the OS. MP3 playback was as good as you're going to get through the audio port, but the 256MB model was almost impossible to get running in anything resembling a decent media device.

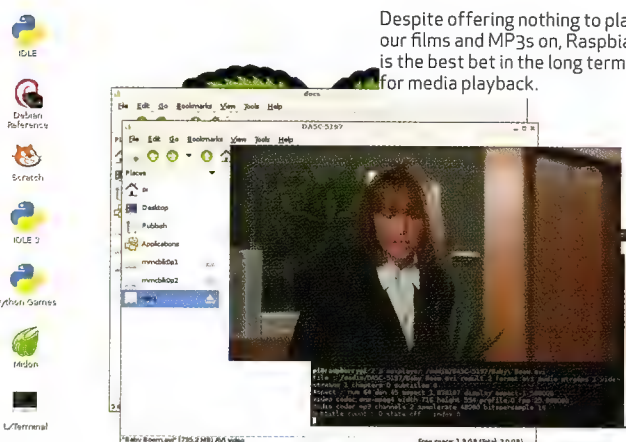
Raspbian didn't have anything to play the movie or MP3s on by default, which is unfortunate as the inclusion of OMXplayer wouldn't break the bank in terms of size. We will grant you that one of the goals of the Raspberry Pi is the users' foray into the world of open source, Linux and so on, and that by learning to use the terminal and software repositories, the user gains a better understanding of the environment they are

working in.

Risc OS didn't do much better — both the movie and the MP3 failed to load, as it did on Plan 9. Although both Risc OS and Plan 9 can make very good media viewers, the default software isn't able to open the most common modern media — but with some tweaking, downloading and installing they can.

Arch is exactly the same. It boots into the terminal, so there's little hope of getting anything graphical to work

Despite offering nothing to play our films and MP3s on, Raspbian is the best bet in the long term for media playback.



out of the box. Arch can be made into an amazing media box, but the learning curve needed may put off inexperienced users.

Verdict

Raspbian	★★★★★
Risc	★★★★
Plan	★★★★
Android	★★★
Arch	★★

Android works on the 512MB model, but Raspbian is best long-term.

ATTITUDES TOWARD SOFTWARE

They may take our OSs, but they can't take our freedom!

All of the operating systems tested here have their source code available from either their respective homepages, or other sources relating to the OS itself; so in essence they are all free, and will most likely continue to be so unless —

of course — things change, in which case the community would most likely be up in arms in a matter of seconds.

Risc OS for the Raspberry Pi is open source, version 5.19, and the code is maintained by a voluntary

group; but the latest version of Risc OS 6 requires the user to sign up for the Select scheme, and is wholly proprietary software, with no public access to the source code. Plan 9, Arch, Android and Raspbian, as we all know, are free to manipulate, install and develop on, as per the ethos of Linux as a whole, and the Raspberry Pi Foundation in particular.

The overall attitudes to software freedom from the collective projects are one and the same, in many respects. The enhancement, further education and use of each of the projects is in accordance with the various regulatory thoughts and aspirations of the open source community, and those managing it.

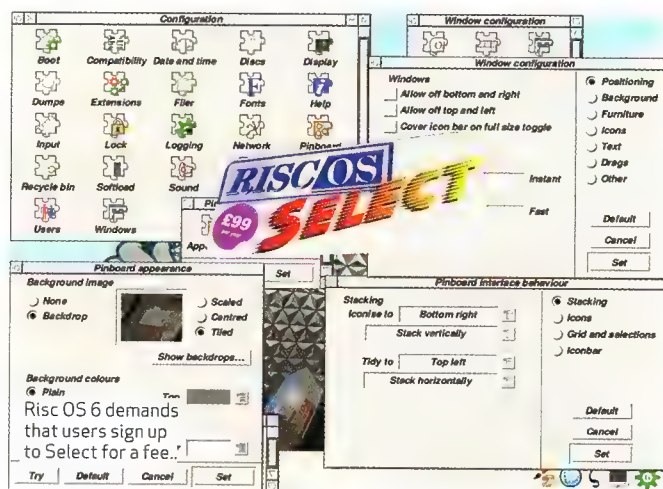
It's a bit of a difficult test to grapple with — the verdict

will see each score the full five stars, as each is free and the attitudes are those of freedom. It's unfair to label Risc OS as being lax in the open source arena because of the closed nature of Risc OS 6, as the community behind the open 5.19 for the RPi is willing and more than able to manage the free software aspect.

Verdict

Raspbian	★★★★★
Risc	★★★★★
Plan	★★★★★
Android	★★★★★
Arch	★★★★★

It's admittedly a cop-out, but five stars all-round for freedom! Yay!



The verdict

Of all the operating systems we looked at here, Raspbian comes out on top as being the most usable, best-looking, having the best range of default software and so on; but the others are snapping at the heels of the Foundation's OS of choice.

For the newcomer, Raspbian is indeed the starting point for their journey, not only into the wonderful world of the Raspberry Pi itself, but also their first steps into the big, wide world of Linux and alternative operating systems. However, once the newcomer is au fait with the intricacies of the operating system, and how the RPi works, then there's a very solid chance that they will instead install the likes of Arch, Risc OS or Plan 9 to become their main operating system for the Raspberry Pi.

Android for the RPi is certainly an interesting project, and one that will no doubt end up being one of the main distributions for the RPi, but there's still some work needed, and in all truth, the Raspberry Pi is nowhere near as powerful a device as the latest crop of Android-powered smart devices.

POWER TO THE PEOPLE

Power being the limiting factor here, the likes of Arch and Plan 9 will come into their own. Their minimalistic and streamlined systems mean that the RPi will tear along without ever hitting the upper limit of the available resources, whereas Raspbian could end up being a very bloated beast if it's not managed accordingly.

Should the Foundation ever produce a significantly more powerful unit, the wealth of operating systems available will no doubt triple overnight. However, the problem therein lies with the cost of such a unit. At the moment, the \$50 price is what's so endearing about the RPi project – with more oomph comes more cost, generally speaking, so at present we have it pretty good with the current batch of operating systems available.

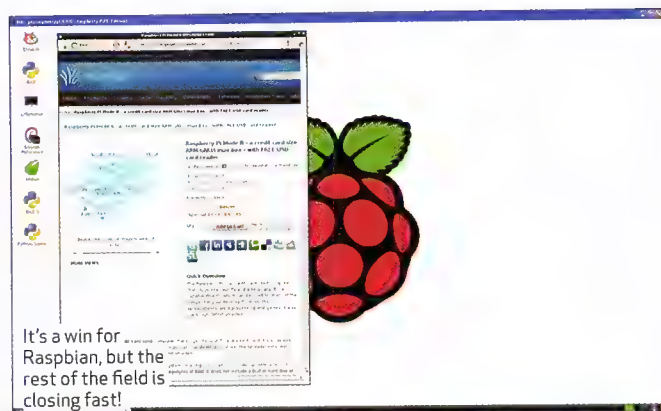
There's no competition here; there's merely the chance for a user to try out their Raspberry Pi, install an OS, use it to their heart's content, learn from it, and – like Linux – evolve into their own custom way of doing things.

So while Raspbian scores the top marks, bear in mind the other OSes represent a project that's standing by, ready for the individual to enjoy and experiment with.

"Install an OS, use it to their heart's content, learn from it, and — like Linux — evolve."

ALSO CONSIDER...

If these operating systems hold little interest for you, then consider PiBang, a Linux distribution inspired by the popular Crunchbang Linux. With an excellent use of Openbox, Tint2 and Nitrogen, PiBang not only looks amazing, it's also a fast, fluid and stable environment. PiBang includes OMXplayer and VLC, but as stated on the PiBang site, "VLC does not currently play videos to a watchable level on the Raspberry Pi, it is installed for testing and for audio playing."



Raspbian ★★★★★

Web: www.raspbian.org

Raspbian is perfect for new Pi users. Experienced users, look elsewhere.

Risc ★★★★★

Web: www.riscosopen.org

With very little effort, Risc OS can be a fully-fledged desktop OS.

Arch Linux ARM ★★★★★

Web: <http://archlinuxarm.org>

Arch requires more experience, but it's more powerful in the end.

Android for RPi ★★★★★

Web: <http://goo.gl/w4eoy>

Barely works on a 256MB RPi, but in time the bugs will be ironed out.

Plan 9 ★★★★★

Web: <http://plan9.bell-labs.com/plan9/>

Looks old-school, but with patience you may get what you want from it.

PiBang offers a full desktop environment, so the educational software has been removed in favour of Abiword, Conky, Gimp and so on. It uses the same software sources as Raspbian, so there's added compatibility. In fact, if PiBang had been included in the operating systems on test here, there's a chance it would have won.

Why wasn't it included? Well, it's an OS that hasn't stood out from the crowd yet. Why, we're not quite sure, because it's very, very good. ■

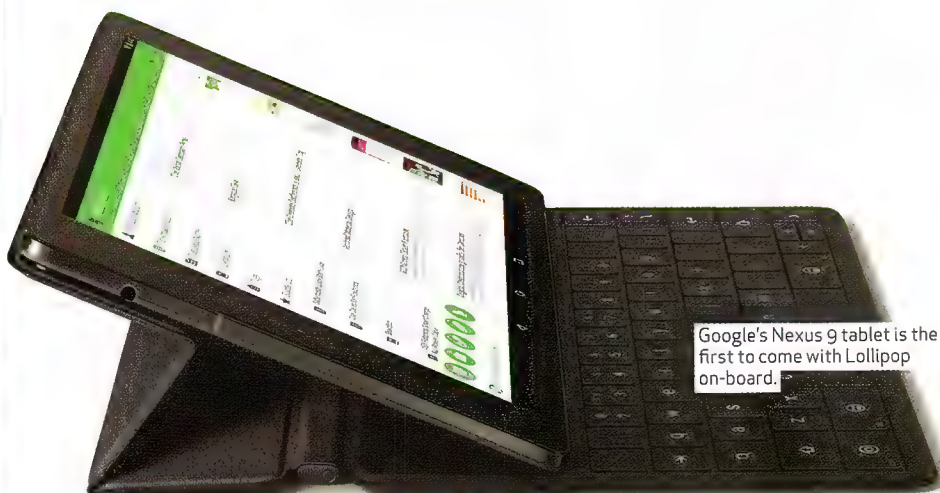


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Get Lollipop features now!

Android 5.0 — aka Lollipop — is beginning to make its way to late-model phones and tablets. Darren Yates shows you some of its high-performance features — and how to get them on older devices.



A new release of Android is normally met with equal parts fanfare and disappointment — fanfare for the new features it brings and disappointment for those with older devices most likely to miss out on the update.

We took a look at the Android L preview a few months ago, but with Lollipop updates now making their OTA debut to a limited number of devices, it's worth looking at some of the features that have found their way into Android 5.0 — and to see how many of them can be had on older devices.

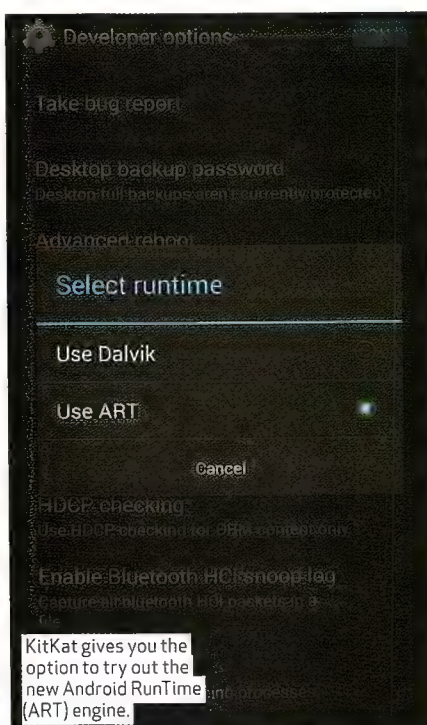
1 FULL-TIME ART

The change of run-time engine from Dalvik to Android Run-Time (ART), initiated with KitKat/Android 4.4, is now complete with Lollipop. The change is a fundamental one to the OS that sees newly-installed apps pre-compiled 'ahead of time', so that the device CPU (predominantly) deals only with native code. Dalvik's just-in time (JIT) compilation was designed for CPUs of another era, where CPU clocks were more valuable. But Dalvik's need to compile every line of code every time the app runs is less efficient on a more valuable mobile resource — battery life.

OLDER DEVICES:

If your Android 4.4/KitKat device isn't in line to receive a Lollipop update, you can still give ART a go. Head to Settings, then 'About phone' and tap on the build number entry five times to

activate developer options. Back out to Settings, scroll down to and select 'Developer options'. Next, scroll down and tap on 'Select runtime' and change it from Dalvik to ART. You'll need a few minutes while your device reboots and begins precompiling your apps, but the result should be slightly faster app loading times. While the theory says battery life should also improve, tests on KitKat's early ART implementation suggest that might not be the case



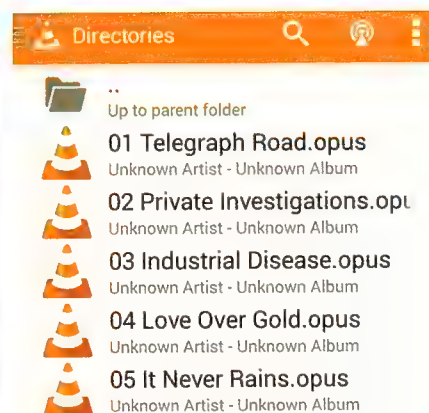
(tinyurl.com/ppdyddz), but we think it's still worth trying, particularly if you're running the latest 4.4.4 update. The downside is that you may run into occasional apps that don't run correctly under ART — hopefully, app updates fix those issues.

To change back to Dalvik, you can just follow the above, but choose Dalvik instead of ART.

2 BETTER AUDIO

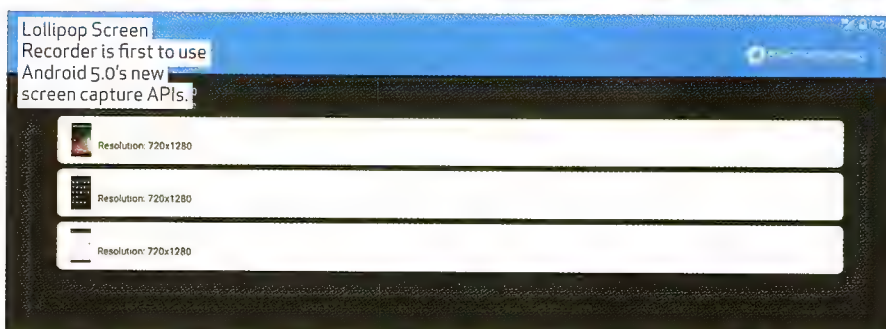
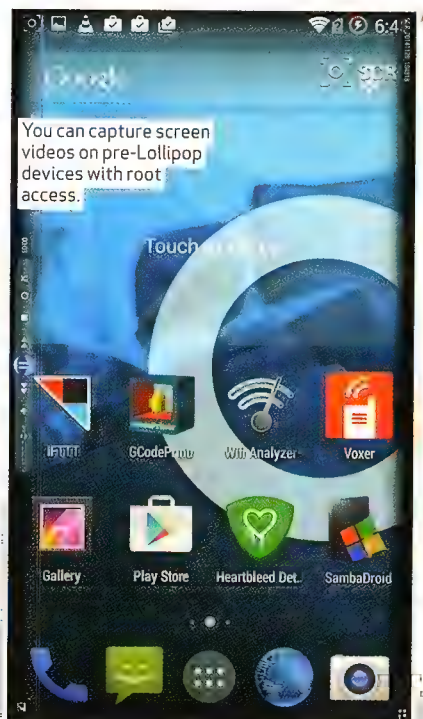
Multi-channel audio processing is a major beneficiary of Lollipop with the ability to now real-time mix up to eight audio channels, giving you support for 7.1-channel audio and potential for some serious-grade audio processing apps.

In line with this, audio capture has also had a major overhaul, with new low-latency capture available via a dedicated processing thread to ensure faster response. Low-latency means delay times from the audio being captured to processing and ultimate



Opus audio files can be played on older devices using VLC for Android Beta. Unknown Artist

0:09



use are as small as possible.

One of the key additions in line with this is the new audio codec called Opus – it's a lossy format said to deliver audio quality better than MP3 at the same bitrate but with only a fraction of the latency. It supports bitrates from 6 up to 510Kbps, sample rates from 8 to

still play Opus audio files on older devices through the latest version of the excellent VLC for Android Beta from Google Play (tinyurl.com/7g69vxp). Unlike most other similar players, VLC is happy to play audio-only files, however, your device needs an ARMv7 or Intel x86

"It's a royalty-free codec and listening tests suggest it's better than most other lossy codecs at similar bitrates."

48kHz and up to 255 audio channels. Importantly for Android, it's a royalty-free codec and listening tests suggest it's better than most other lossy codecs at similar bitrates. Opus is gaining fans in the VoIP industry, thanks to its combination of audio quality at low-bit rates and that low-latency.

But for audio fans, arguably the most useful addition to Lollipop will be new support for standard USB audio devices. You'll now be able to plug into USB host or USB-OTG ports all manner of headphones, speakers, microphones and audio devices.

OLDER DEVICES:

It's highly unlikely you'll see an update that natively incorporates Opus into earlier Android releases, but you can

CPU for the app to work – but that's almost every device released in the last three years.

As for native support for USB audio devices in pre-Lollipop phones and tablets, the best you could describe of it is 'patchy'. If high performance audio is important to you, it may be reason enough to wait for more Lollipop devices to hit the market.

3 BETTER CAMERA & VIDEO

New Android releases are always accompanied by many new and improved application programming interfaces (APIs) and Lollipop is no exception. Some of the more than 5,000 new APIs that will be most welcome apply improvements to the on-board camera image and video capturing.

It'd be fair to say phone cameras haven't kept pace with their standalone cousins in terms of genuine image processing, but Lollipop should change that thanks to new API support for capturing raw image data formats including YUV and Bayer RAW. Not only that, you can also capture metadata such as exposure settings, even noise models and lens information. Having this level of detail should enable developers to come up with apps that not only allow you finer-grain control, but importantly, take better pictures.

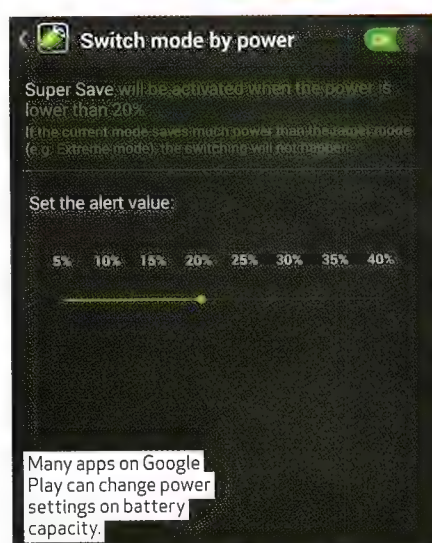
Video isn't left out either, with Lollipop gaining the services of highly-anticipated H.265 video encoding/decoding. H.265 or 'High-Efficiency Video Coding' is the next-generation video compression standard that's said to offer the same video quality as H.264 but needing only half the bitrate – that's quite extraordinary given the battles researchers have had over the years to improve compressed video quality.

OLDER DEVICES:

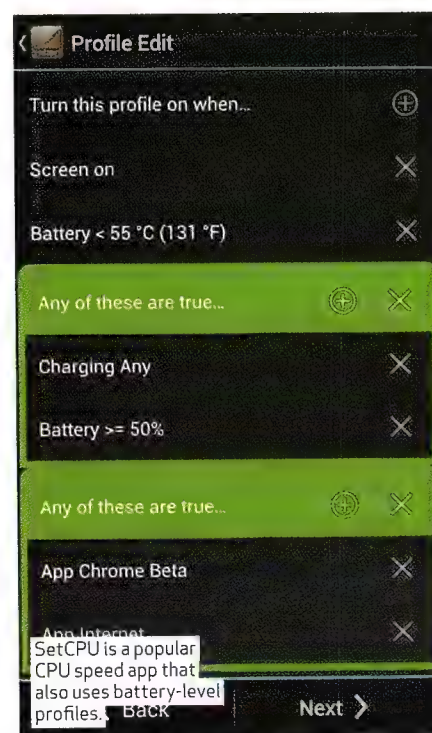
Not having the requisite APIs means there's not much developers can do to improve image quality on older Android-based device cameras. However, again, while HEVC may only be native to Lollipop, you can play HEVC files on older devices through the latest version of the extremely capable MX Player from Google Play (tinyurl.com/6o34ajg). MX Player uses the libavcodec library as its decoding engine (the same one used by FFmpeg and many other video decoders/encoders) and already supports both



Android 5.0 adds support for optical heart rate sensors — so does Fitbit.



Many apps on Google Play can change power settings on battery capacity.



SetCPU is a popular CPU speed app that also uses battery-level profiles.

4K video and H.265 formats.

Lollipop's H.265 encoder/decoder comes from Indian multimedia developer Ittiam Systems (tinyurl.com/pjeomjb), but appears to be software-based only. If that's the case, Lollipop users may see higher CPU usage as a result, compared with hardware-accelerated formats such as H.264. It's still early days, but it'll be interesting to see if Lollipop's H.265 codec is more efficient than MX Player's alternative.

If there is a likely limitation of playing HEVC video on older devices, it will simply be a lack of CPU performance. Devices with a multi-core CPU should have greater success.

4 SCREEN CAPTURE

Screen capturing has spawned an entire education sector on Windows PCs, but Lollipop now enables software developers to incorporate the feature into new apps — even share the screen live over a network (with user permission). Already apps supporting the new APIs are appearing on Google Play — and because they use native APIs, there's no need for root access. You can try out Lollipop Screen Recorder at (tinyurl.com/madl6xu).

OLDER DEVICES:

Without the native APIs, older devices typically need root access to enable capturing of screen contents. You won't be able to live-share screens over a network with pre-Lollipop gear, but you can capture them to storage using a number of apps on Google Play. The only drawback, again, will likely be with older devices running single-core CPUs struggling to keep up with the load, but multi-core CPU devices should fare better.

There are a number of screen recording apps available on Google Play — Rec needs at least Android 4.4, but trialware SCR Screen Recorder Free should work with rooted devices going back to ICS/Android 4.0.3 (tinyurl.com/17w4r9k).

5 NEW SENSORS

The wearable computing market is going nuts over optical heart rate monitors at the moment. It's as if everyone's just figured out how to make green LEDs and sensors talk to low-power 32-bit ARM CPUs and they're beginning to appear in everything from new fitness bands to next-generation smartwatches.

Lollipop isn't missing out either with new support for heart rate sensors, plus new tilt detection sensors. It also includes new 'interactive composite sensors' that are able to detect different gestures including wake up, pick up and glance.

< Decoder

H/W audio track selectable

If h/w decoder natively supports selecting audio track, playback of secondary audio tracks will become smoother. ☒

SOFTWARE DECODER

S/W decoder (local)

Use s/w decoder for local files stored on the device. ☒

S/W decoder (network)

Use s/w decoder for playing remote network sources via HTTP, FTP, RTSP, MMS and more. ☐

S/W audio

Use s/w audio decoder instead of h/w audio decoder. ☐

CPU core limit

Specify the maximum number of CPU cores to be used for s/w decoding.

Color format

YUV is experimental and does not work on all devices.

Use speedun tricks

Use MX Player's Decoder settings screen to set auto-use of software codecs.

OLDER DEVICES:

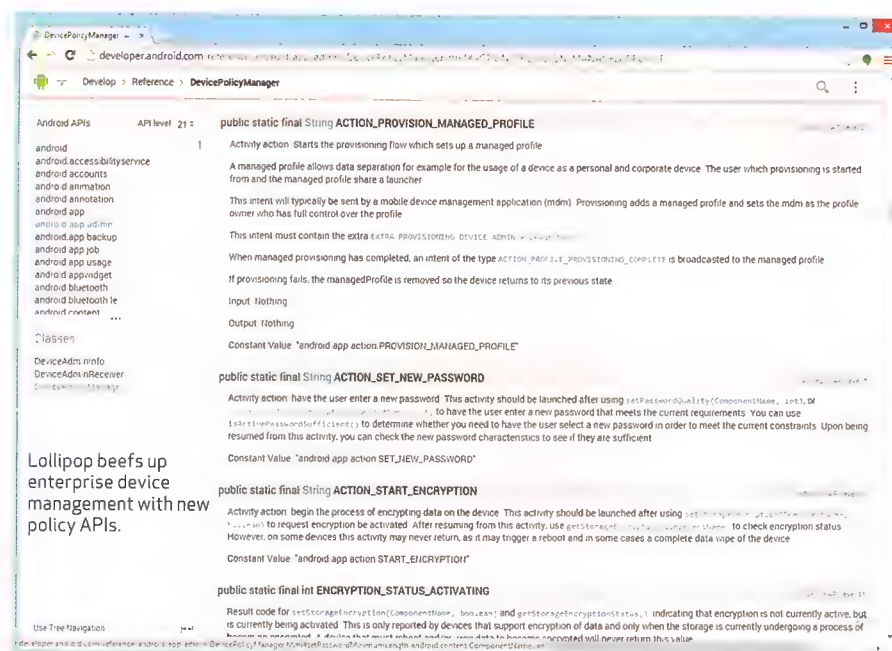
Details are sketchy on just what the new interactive composite sensors include, but pre-Lollipop, Android already makes use of composite sensor reading, using combinations of accelerometer, gyroscope and magnetometer to measure everything from linear acceleration, step counting and gravity (tinyurl.com/mrtzvy6).

Optical heart rate monitoring uses green LEDs to flash light onto the skin that is reflected into photodiodes to indicate blood-oxygenation and flow. While not impossible to do on older Android devices, new APIs will make development under Lollipop much easier. So, for now, it might only be Lollipop that gets access to built-in heart-rate monitoring — but you could always just go and buy a Fitbit Charge HR.

6 BETTER POWER MANAGEMENT

Each time Google sets up for a new major update of Android, the search giant gets a bee in its bonnet about one particular area and goes at it, hell for leather, seeking improvements — think 'Project Butter' from Android 4.1/Jelly Bean. For Lollipop, it's called 'Project Volta' with its aim to improve overall power management and battery life.

One of those improvements it now offers is the ability to auto-activate a battery saver mode that reduces some functionality once the battery level drops to either 15% or 5%, respectively. The new feature is fairly rudimentary in terms of tweaks, but like many other



Lollipop beefs up enterprise device management with new policy APIs.

new Lollipop extras, developers can incorporate it into new apps through new APIs.

OLDER DEVICES:

Somewhat surprisingly, this is an area where Google is playing a bit of 'catch-up', given software developers have been delivering battery-monitoring performance management apps for a number of years. SetCPU (tinyurl.com/7pgo5cp) and Go Battery Saver & Power Widget (tinyurl.com/78yegwo) are just two examples that allow you to activate power saving modes once a certain level of battery capacity remaining is reached. They work on almost all Android devices from Froyo/Android 2.2 up, although SetCPU requires root access. Lollipop's ability to enable battery saving automatically within apps is something new however.

7 BYOD MANAGEMENT

But if there's one area where Android has struggled to respond to the likes of BlackBerry and Apple, it's enterprise security. The 'Bring Your Own Device' (BYOD) movement has been a boon for users wanting the convenience of using their own tech in their work environment. It's also a boon for business that doesn't have to pay for the devices. But the people who suffer most from it are the system administrators struggling to get an ever-increasing variety of devices all talking happily on the corporate intranet without introducing a nightmare of security issues that could bring down the whole thing in a jiffy.

A key aim of Lollipop is to boost Android's reputation in the enterprise market as a serious alternative to BlackBerry and Apple. To that end,

Lollipop introduces what it calls a 'managed provisioning process' that sets up a separate profile or container within the device to control corporate-installed apps. These apps appear alongside your personal apps on the launcher but have a work badge attached to the app icon to indicate their separate profile.

OLDER DEVICES:

While Samsung's Knox has been a



nuisance to those wanting to gain root access and flash custom ROMs onto their Galaxy devices, it's just about the best solution available for providing enterprise-grade security and protection for Android devices. So it's not surprising that many of Lollipop's gains in this area have come from Knox itself (tinyurl.com/mymcwst).

The combination of Knox with popular mobile device management (MDM) platform, MobileIron, has made it easier for enterprises to allow Samsung Galaxy devices access to corporate networks, giving an advantage to the Korean giant over its Android competitors. That said, MobileIron is a popular MDM solution for Android, full stop.

For pre-KitKat/Android 4.4 and non-Samsung devices, chip giant Intel put out a short white paper on how it handled BYOD management for some 20,000 Android devices (tinyurl.com/necfnpm). In short, Intel IT developed a five-level trust quotient that determined just how far up the corporate data chain a device was allowed to play with. It's well worth a quick read.

STILL LIFE YET

Android 5.0 is a significant update incorporating some of the many improvements made by OEMs and software developers alike and there's no doubt it's designed to get more Android devices through corporate doors. However as we've seen, a number of Lollipop's features can be had on older devices – maybe not quite to the same degree, but certainly there's no need to ditch your older Android device just yet. ■





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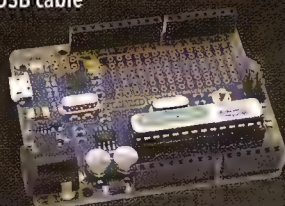
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100% Arduino compatible. Based on Arduino Uno but with improvements. Top spec ATmega328P Microcontroller, independent prototyping area, visible LEDs, and Micro-USB connector to power from most cellphone chargers! Includes USB cable and guide sheet.

XC-4210



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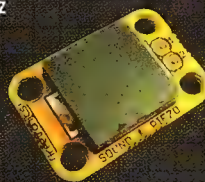
Plenty of shields, sensors and modules to choose from for you to customize your project and take it to the next level.

SOUND BUZZER MODULE

This versatile piezo-element module can be used for either input or output. It can be used as a noise-maker driven by your microcontroller for audible feedback of events, and it can also be used as a knock-detector input to sense events and react to them. Make your timekeeper buzz!

- Frequency response 0-20kHz, peak resonant frequency: 4KHz +/- 500Hz
- Size: 23(W) x 16(H) x 5(D)mm

XC-4232



PROTOSHIELD BASIC

This low-cost prototyping shield fits directly onto an Arduino compatible board such as the Eleven and has a large general-purpose area in the middle where you can solder on workshop just in case you get the urge to build something extra.

- Gold plated
- Top and bottom overlay
- Mounting pads for power on LED and current-limiting resistor
- Size: 59(L) x 53(W)mm

XC-4214



MATRIX DISPLAY PANELS

This large, bright 512 LED matrix panel has onboard controller circuitry designed to make it easy to use straight from your board.

- 32 x 16 high brightness LEDs on 10mm pitch
- Viewable over 12 metres away

Available in 2 models:

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ARDUINO EXPERIMENTER'S KIT

Everything you need to get started with the exciting new world of Arduino. Kit includes "Eleven" Arduino compatible board, servo motor, lights, switches, breadboard and more.

Complete with instructions, a supporting web page and software examples.

- No soldering required

XC-4262



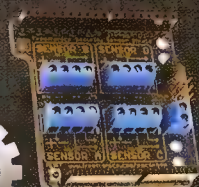
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SECURITY SENSOR SHIELD FOR ARDUINO

This shield allows up to 4 security sensors to be connected to detect a variety of events using a single cable pair to the sensor. Add a PIR sensor to the timekeeper and you will have a motion-triggered stopwatch.

- Supports PIR motion sensors, microwave sensors, glass break detectors, etc
- Status LEDs on each channel

XC-4217



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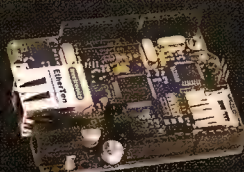
ARDUINO ESSENTIALS

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ETHERTEN

100% Arduino compatible. Combines all the features from Eleven and the Ethernet Shield in a single, integrated board. Do Twitter updates automatically, surf web pages, connect to web services, display sensor data online, and control devices using a web browser. Features built-in microSD card slot.

XC-4216

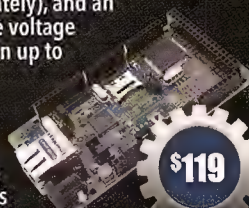


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- 10/100base-T Ethernet
- 54 digital I/O lines
- 16 analogue inputs

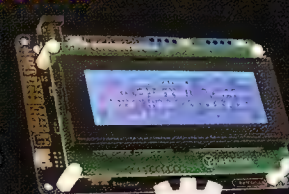
XC-4256



STEPUINO BOARD

A self-contained board with 2 x 4-wire stepper motor controllers, servo interface, microSD card slot, and 20x4 character LCD. Perfect for building robots or other mechatronics projects: just connect the stepper motors and go!

XC-4249



Arduino Basics #4 – The power of binary and LEDs

In his ongoing series, this month Darren Yates shows how to use LEDs and switches to control a number of easy Arduino projects.

Light-emitting diodes (LEDs) are the simplest and cheapest indicators to show the user what's going on inside your Arduino project, whether you're just indicating the power is on, or some specific function is operating. But you can also have some serious fun with them too and investigate the world of binary numbers. This month, we're making three projects with the same hardware and related software – a binary counter, a 'Knight Rider' display and a binary adding machine.

PARTS YOU'LL NEED

Here's a quick list of what you'll need:

- Arduino Uno/Freetronics Eleven microcontroller board
- 6 x red LEDs (or any colour will do)
- 6 x 470-ohm resistors (any value between 330-1000ohms will do)
- Arduino prototype shield (for example, tinyurl.com/19xbfrj) or any prototyping breadboard
- Dupont jumper wires

LEDs must be installed the right way for them to light up.



5mm LED

Anode (A)

Cathode (K)

- 2 x PCB momentary-on pushbutton switches

Or you could just get the Freetronics Experimenters Kit from Jaycar Electronics.

All three projects this month use the same circuit design – once you've built it, you can flash the Arduino board with each source code to create each of the different projects.

PROJECT #1 – BINARY COUNTING

We might be comfortable counting in decimal (by tens), but computers much prefer counting by twos or in 'binary'. In fact, binary numbers are so fundamental to computing that not having them just doesn't bear thinking about. Using six LEDs and six 1k-ohm resistors, we can simulate a binary counter counting from zero to 63 ($2^6 - 1$). Each LED is connected in series with a 470-ohm resistor to digital outputs D5 through D10.

Our simple code increments an integer variable (count++), counting up from zero and using some simple maths, we convert that decimal number into binary where each digital output D5 to D10 represents one of the binary digits

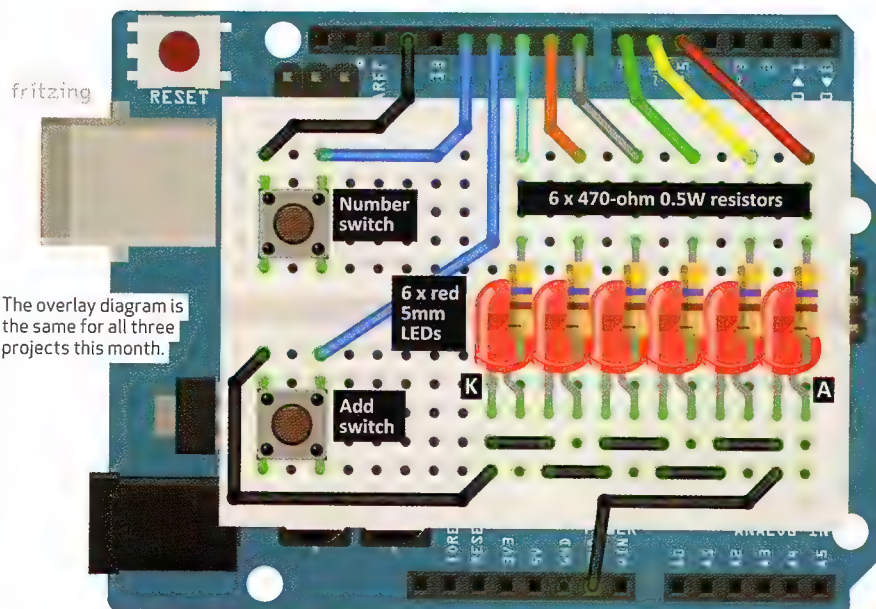
that make up the number.

The 'displayBinary' method is where all the hard work takes place and we're using a simple decimal-to-binary conversion technique whereby you divide the decimal number by two (number % 2) and the remainder or 'modulus' becomes one bit of the answer; meanwhile, the quotient is again divided by two and its remainder becomes the next bit of the answer and so on. The for-loop inside the display Binary method takes care of this.

PROJECT #2 – KNIGHT RIDER DISPLAY

Separating the display portion of the code not only makes it easier to read, but easier to modify, too. It's universally recognised that 1980s' TV peaked with *Knight Rider* and we can replicate the side-to-side display of the *Knight Rider* car, KITT, with just a small modification to our original binary counter code.

Remember from that code, each LED represents a binary digit, a power of two. If we change the increment code from 'increment by one' (count++) to 'double the result' (count*=2), we can use this 'power of two' to make each LED



Adding 14, 12 and 7 with the Adding Machine

Enter 14	Binary output
NS NS NS NS NS NS NS	32 16 8 4 2 1
NS NS NS NS NS NS NS	
Press Add button	Binary output
AS	32 16 8 4 2 1
Enter 12	Binary output
NS NS NS NS NS NS NS	32 16 8 4 2 1
NS NS NS NS NS NS NS	
Press Add button	Binary output
AS	32 16 8 4 2 1
Enter 7	Binary output
NS NS NS NS NS NS NS	32 16 8 4 2 1
NS NS NS NS NS NS NS	
Press Add button	Binary output
AS	32 16 8 4 2 1

Add numbers together in binary using our Binary Adding Machine.

turn on individually from right to left. To get the display to light up in the other direction, we halve the count and store it (count/=2).

The code's loop method now contains two 'for' loops doing exactly those two tasks – the first doubles the count variable value between one and 32 (1, 2, 4, 8, 16, 32) while the second halves the count variable value from 32 down to one (32, 16, 8, 4, 2, 1). The result is this side-to-side motion as each of the LEDs lights up on its own in turn.

You can change the speed by changing the two delay values – increasing the value slows it down, decreasing it speeds it up.

PROJECT #3 — SIMPLE ADDING MACHINE

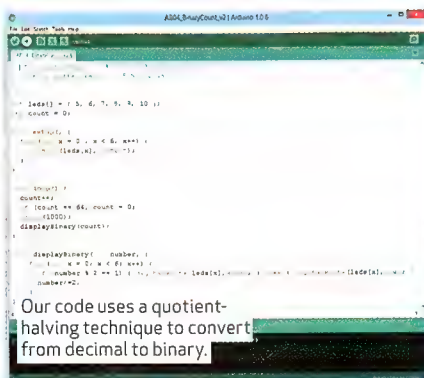
Our last project expands the binary

How binary numbers work

Counting in decimal is easy – each digit in the number counts a power of or 'base' ten. To show this more vividly, we can write it another way, for example, 314 can be written as 31410 or as $3 \times 10^2 + 1 \times 10^1 + 4 \times 10^0$.

Binary numbers aren't too dissimilar – they just count by powers of or 'base' two. We could write 101012 as $1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$.

In our project, each binary digit is represented by an LED – lit and it's a '1', off and it's a '0'. What computers spend their days doing is converting decimal numbers to binary and back again, so writing 2410 as a binary number would be 110002, which equals $1 \times 2^4 (16) + 1 \times 2^3 (8)$. We know it's correct, simply because $16 + 8 = 24$.

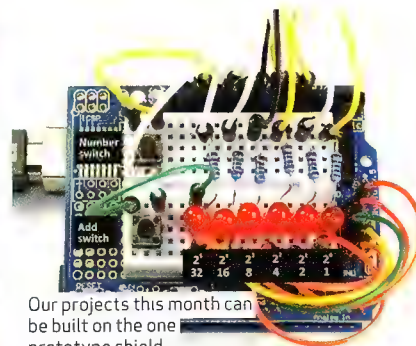


Our code uses a quotient-halving technique to convert from decimal to binary.

counter by incorporating two button switches and some code mods to turn it into a basic six-bit adding machine. It has a maximum count of 63, but it can add multiple numbers together using a simple computing technique called 'add and store'.

If you follow the overlay diagram, you'll have two button switches – 'number' and 'add'. You start by entering your first number by pressing the number button until your number appears in binary on the LEDs. You press the add button to add your number to the total or, if this was a CPU architecture class, we'd call it the 'accumulator'. Press the number button again to light up your second number and press the plus button to see the sum.

The flow chart shows how this works for adding three numbers – 14, 12 and 7. Start by pressing the number button 14 times until you see 14 appear on the LED display in binary (8+4+2). Next, press the add button to add it to the total. Press the number button 12 times until you see 12 appear in binary (8+4). Press the add button again and the LEDs will display the sum of 26 (16+8+2).



Our projects this month can be built on the one prototype shield.

Following this procedure, you can keep adding new numbers until the accumulator rolls around to zero or 'overflows'.

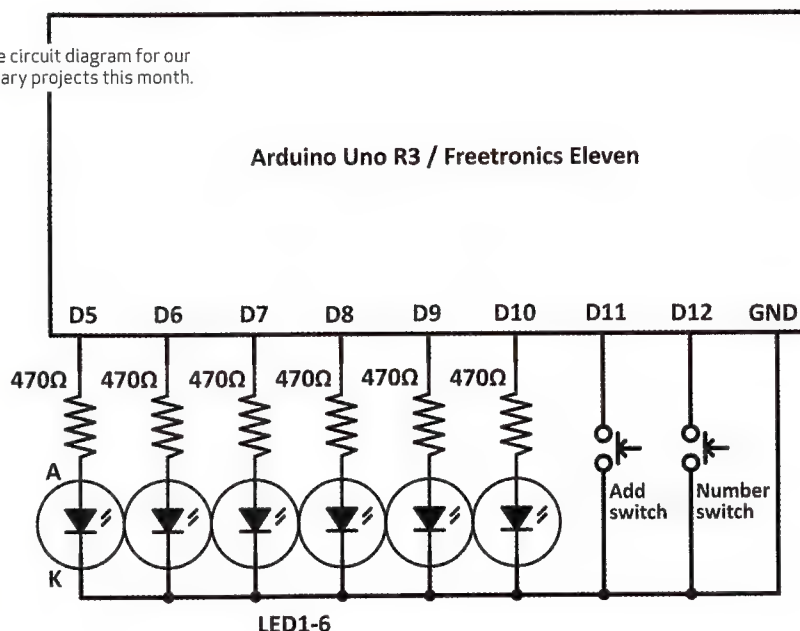
You can also keep adding multiples of your current 'number' by just pressing the 'add' button and watching the LEDs add it each time.

Reading binary numbers is still a skill taught at university and if you find it a struggle converting decimal to binary and back again, this little project might just help.

Get the source code

You'll find the source code for this month's projects at our web site at apcmag.com/magstuff.htm. There are no special libraries needed – just build up the project, load, compile and flash the source code to the Arduino board using the Arduino IDE v1.0.6 software (you can download it free from arduino.cc/download).

The circuit diagram for our binary projects this month.



ARDUINO BINARY ADDING MACHINE

Part 4 – Looping the loop

This month, Darren Yates continues his Java coding series with a look at different types of loops.

In the first three parts of this series, we've learnt how to output text to the screen, declare and use variables, perform basic mathematical expressions, get user input from the keyboard and how to use if-else conditional statements. We combined all of those in our first major project, the CoffeeCup app for a new coffee shop.

But the apps we've written so far all have one major issue – they only run once and stop. Last time, we mentioned that our CoffeeCup app can't handle a customer buying multiple cups of coffee. To try and fix this, we could throw in another if-else statement to check if the customer wants a second coffee, but then we have to also replicate the whole coffee-choice codeblock as well. What happens if they want three coffees? Or four? Hopefully, you can see using if-else statements alone gets messy very quickly. A much smarter way is to incorporate a loop.

LOOPS

Loops enable you to run a chunk of code multiple times based on a condition, so in a sense, they're a complex version of our if-else statement from last time. They're such an essential code function, most high-level languages (including Java) include three different types – the 'for' loop, the 'while' loop and the 'do-while' loop.

FOR LOOPS

A for-loop is ideal for when you know the number of times you want the code inside the loop to run. Here's a basic implementation:

```
for ( x = start_value; x <
end_value; increment x ) {
    Code-statement(s)_to_loop;
}
```

Putting it simply, you first indicate the start condition, followed by the end condition and finally, how you get from the start to the end condition. Let's try a practical example – say you want to write an app that displays the times

tables of a particular number from zero to 12. Since we know we need 13 mathematical expressions (zero to 12), we can use a for-loop with this code fragment:

```
System.out.print("Enter the
number (0 to 12) for the times
table: ");
int ttable = input.nextInt();
for ( int y = 0; y < 13; y =
```

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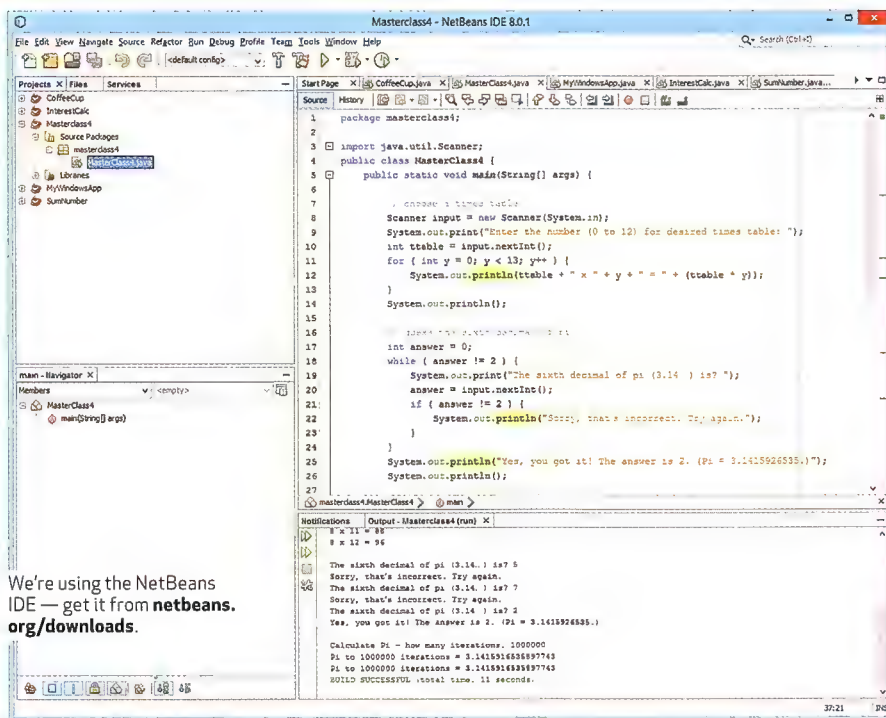
Get the code

Grab the full source code for this month's class on our website at apcmag.com/magstuff.htm. You'll find two zipped projects — CoffeeCup for our on-going CoffeeCup project and Masterclass4 for everything else. Unzip each for the source code inside.

Output - CoffeeCup (run)

```
run:
Welcome to the Coffee Cup!
Please select your beverage: (1 - short black, 2 - latte): 1
You'd like a short black. Coming right up! Price: $3.80
Would you like to order another coffee? (0 for no; 1 for yes): 1
Please select your beverage: (1 - short black, 2 - latte): 2
What type of milk would you like?
(1 - normal, 2 - skim, 3 - soy): 2
You'd like a latte with skim milk! Sure thing! Price: $4.25
Would you like to order another coffee? (0 for no; 1 for yes): 1
Please select your beverage: (1 - short black, 2 - latte): 2
What type of milk would you like?
(1 - normal, 2 - skim, 3 - soy): 1
You'd like a latte with normal milk! On its way! Price: $4
Would you like to order another coffee? (0 for no; 1 for yes): 0
Total cost: $12.05 - please pay at register.
BUILD SUCCESSFUL (total time: 32 seconds)
```

Our Coffee Cup project now tallies cost and allows multiple orders.



We're using the NetBeans IDE — get it from netbeans.org/downloads.

```
The sixth decimal of pi (3.14...) is? 6
Sorry, that's incorrect. Try again.
The sixth decimal of pi (3.14...) is? 5
Sorry, that's incorrect. Try again.
The sixth decimal of pi (3.14...) is? 2
Yes, you got it! The answer is 2. (Pi = 3.1415926535.)
```

The output of our code guessing the sixth decimal of Pi.

```
y + 1 ) {
    System.out.println(ttable +
" x " + y + " = " + (ttable *
y));
}
```

There's plenty happening in that first line of the for-loop. First, we declare the variable `y` and initialise its value to zero — that's the start condition. The end-condition here is '`y < 13`' — that means while ever the 'end' condition (`y < 13`) is true at the start of each loop, run through the for-loop codeblock below.

When the loop or 'iteration' is completed, perform the 'increment' function, which in this case, is adding one to the value in `y`. After that, go back and run the loop again.

Once the end condition (`y < 13`) is false, the for-loop skips the loop

codeblock and code execution jumps to the first code line after the loop.

INCREMENT SHORTCUTS

Time for a quick detour — when you add to a variable, you take the value of that variable, add something to it and save the result back into that variable — that's what the code statement `y = y + 1` does. You perform the right side of the equal sign first (add one to the value of `y`), then assign (=) the new value back into `y` on the left.

Shortcuts are very handy, so here's one to remember — you can rewrite `y = y + 1` as `y++`. Want to increment `y` by two? Use the shorthand `y+=2`, which means take the value of `y`, add (+) two and assign (=) the value back to `y`.

If we go back to our times table for-loop, we can rewrite that code as:

```
for ( int y = 0; y < 13; y++
) {
    System.out.println(ttable +
" x " + y + " = " + (ttable *
y));
}
```

And it works a treat. (Just remember those semicolons!).

WHILE LOOPS

But you won't always know how many times you'll need to loop a chunk of code. For example, a simple number-guessing game — what is the sixth decimal of 'Pi'? We know the answer is a single digit between 0 and 9, but not how many times it'll take the user to guess it. We have a desired result but while ever the user answer doesn't equal that result, we'll ask them to have another go. We can do that with a 'while' loop:

```
while ( condition_is_true )
{
    code statement(s);
}
```

The while-loop checks the test condition and if it's true, runs through the code statement(s) section once, then checks the test condition again. But if that initial check is false, it skips the code statement(s) section altogether, moving onto the next line of code after the end-brace '}'. Here's one way you could write this part of the code for our Pi example:

```
answer = 0;
while ( answer != 2 ) {
    System.out.println("The
sixth decimal of pi (3.14...)
is? ");
    answer = input.nextInt();
    if ( answer != 2 ) {
        System.out.println("Sorry,
that's incorrect. Try again.");
    }
    System.out.println("Yes, you
got it! The answer is 2.");
}
```

We start by initializing the variable `answer` to zero. We know the initial while-loop test condition (`answer != 2`) will be true, since the value of `answer` is not equal to 2, so it runs through the loop code. We ask the user for an answer and if they answer '3', the next

Loop ready-reckoner

for-loop	0 < loops < known
while	0 < loops < unknown
do-while	1 < loops < unknown

This is an easy way to remember Java's three main loop techniques.

Calculate Pi - how many iterations: 1000000

Pi to 1000000 iterations = 3.1415936535887745

Pi to 1000000 iterations = 3.1415936535887745

BUILD SUCCESSFUL (total time: 11 seconds)

One million iterations and our code only makes Pi to five decimal places.


```

Output - Masterclass4 (run) X
run:
Enter the number (1 to 12) for desired times table: 8
8 x 0 = 0
8 x 1 = 8
8 x 2 = 16
8 x 3 = 24
8 x 4 = 32
8 x 5 = 40
8 x 6 = 48
8 x 7 = 56
8 x 8 = 64
8 x 9 = 72
8 x 10 = 80
8 x 11 = 88
8 x 12 = 96
    
```

Times tables are prime for implementing Java's for-loop.

if-statement will be true ($3 \neq 2$) and we'll ask the user to try again. The code hits the last end-brace and goes back to the 'while' codeline to check the condition again. It checks, but since the value of variable answer is now 3, it's still wrong, so it runs through the code loop once more, asking the user to give an answer. This time the user answers '2'. The if-statement is now false, since $2 \neq 2$ is false ($2 = 2$ is always false), so the 'try again' text is not displayed. The app hits the last end-brace again and returns to the while codeline, but this time, the test condition is false because the answer response is '2', so the while loop stops, skips the loop code and runs the first codeline after the while end-brace, which is to tell the user the answer is correct.

Hopefully, you can see now why the

indentation of inner code is so important – it makes following the code path so much easier. (By the way, Pi is 3.1415926 to seven decimal places.)

DO-WHILE LOOPS

The do-while loop is a slight but important variation on the standard while loop in that a do-while loop will always run the inside loop code once, even if the condition is false initially, whereas the while loop in that case won't run it at all. Or in other words, a while-loop checks before it loops and a do-while loop loops before it checks.

Last month, we started coding a simple user interface app for a new coffee shop called the Coffee Cup that allowed customers to choose their order and have it automatically sent to

the barista team. The problem was that you could only order one coffee. Here's where we fix that.

INFINITE COFFEE!

We add two variables called price and total to keep track of our coffee prices and tally up the total the customer owes. Next, we surround almost the entirety of last month's code with a do-while loop. We ask the customer the type of coffee they would like, ask about the milk choices, and finally, we tally up the total cost.

Now the last thing we do is ask the customer would they like to order another cup of coffee and to return an answer. That concludes the code block, even though we haven't checked the customer's answer – we do this in the while-loop conditional statement where we tell the code to loop again as long as the customer choice inside choice.nextInt() is anything but zero.

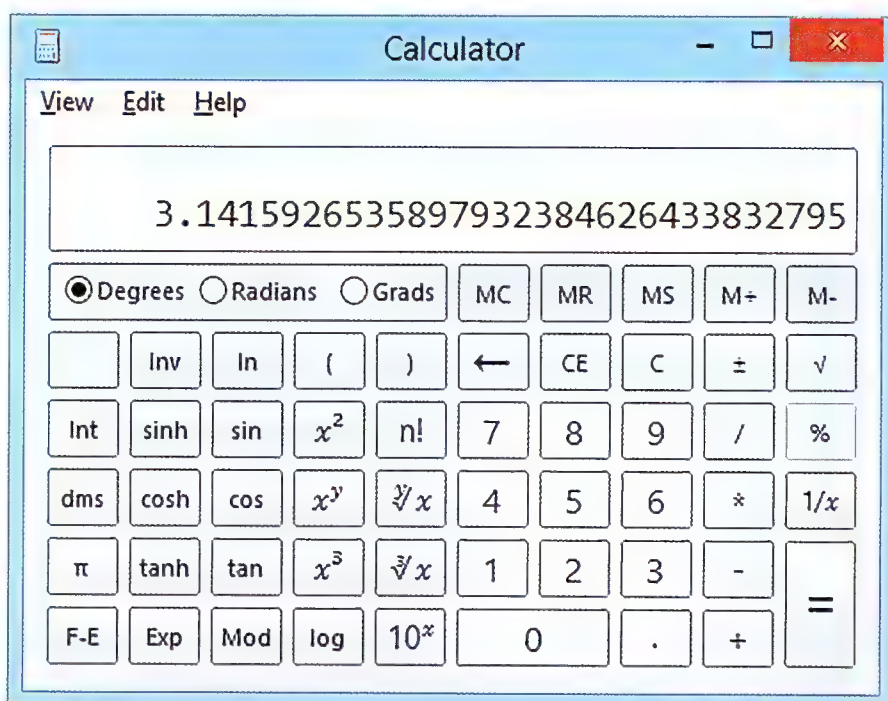
So with just a handful extra lines of code, we not only add in price calculations, but we enable the code to handle the customer asking for an (almost) infinite number of coffees.

CHOOSING WHICH LOOP TO USE

A common question you hear when first learning about loops is which one should you use at which time? In many cases, they are interchangeable – you can code them all to perform the same function. For example, you can make a while-loop run through a fixed number of runs or 'iterations' by incrementing a variable inside the loop and using the while condition test to see if the variable value equals a certain number – just like a for-loop.

But it's always good to know how to use all three, so here's a basic rule-of-thumb:

- For-loops are the best option when you know you need a fixed number of loops.
- While-loops are the choice for when you don't know how many loops you'll need.
- Do-while loops are the choice when you don't know how many loops you'll



Windows Calculator shows the value of Pi to plenty of decimal places.

```

1
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40
    
```

Find the code for this project at apcmag.com/magstuff.htm.

need but you need to run through the loop at least once.

These aren't the only loop functions Java has but if you can master these three, you're pretty much set to do anything.

CALCULATING PI

In our last code this month, we're manually calculating the number pi. You may remember using Pi back from school maths days in calculating the area or circumference of a circle, but pi is an important number in everything from electrical engineering to calculating JPEG image compression.

There are a few ways to calculate Pi manually, one being the Gregory-Leibniz convergent infinite series (tinyurl.com/7xe6e8d) – it's not particularly efficient (as you'll see, you only get the first five decimal places after one million iterations), but it's easy to code and is based on the series:

$$\pi / 4 = 1 - (1 / 3) + (1 / 5) - (1 / 7) + (1 / 9) - \dots$$

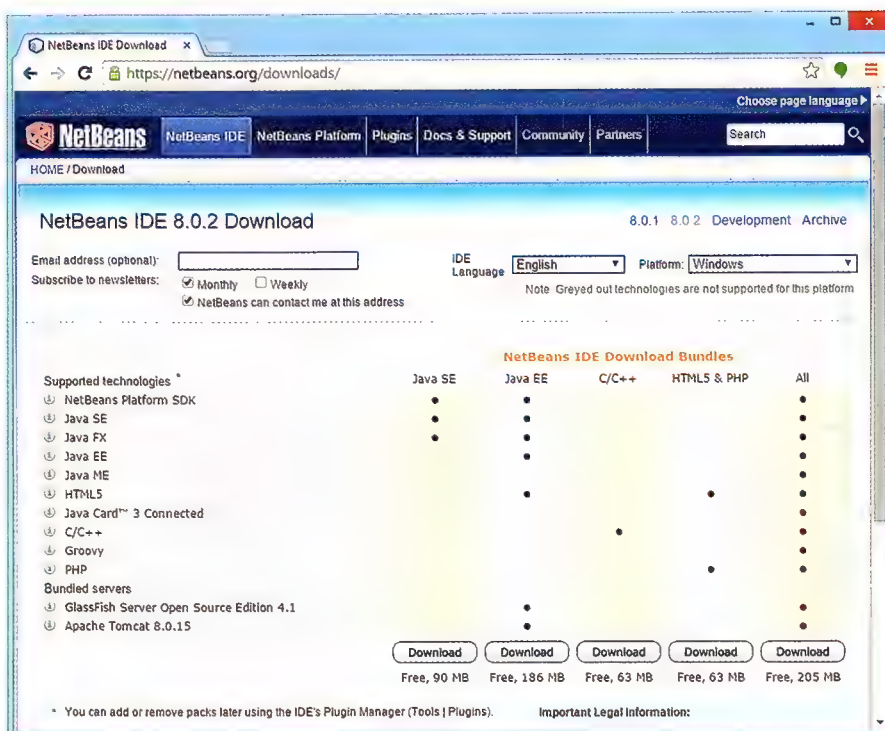
We can put the whole formula inside a do-while loop:

```
int loopCount = 0;
double pi = 0;
do {
    pi += ( Math.pow(-1,loopCount) / (2 * loopCount + 1) ) * 4;
    loopCount++;
} while ( loopCount < answer
&& loopCount <= 10000000 );
System.out.println("Pi to "+
loopCount + " iterations =
"+pi);
```

This is the most complex code we've done, so take your time – check the full Masterclass4.java source code in this month's download. The first two lines set up the integer variable loopCount plus the double-precision variable Pi. The loopCount variable keeps track of the number of times around the do-while loop and Pi will hold calculation of Pi.

Inside the do-loop, we use a Java maths function called Math.pow to raise the number '1' to the power of the value in the loopCount variable and divide the result by two times the value of loopCount plus one. We multiply the whole result by four and add that to the current value of Pi. After that, we increment the loop Count variable.

The closing curly brace ends the codeblock and we now check the do-while condition, which is to loop again while loopCount is less than answer variable value (this comes from user input asked previously but not shown here). Once this condition is false, the loop stops and the System.



Install JDK8 first, followed by NetBeans for a smooth coding setup.

```
// Gregory-Leibniz series for calculating Pi using a do-while loop
System.out.print("Calculate Pi - how many iterations: ");
answer = input.nextInt();
int loopCount = 0;
double pi = 0;
do {
    pi += ( Math.pow(-1,loopCount) / (2 * loopCount + 1) ) * 4;
    loopCount++;
} while ( loopCount < answer && loopCount <= 10000000 );
System.out.println("Pi to "+ loopCount + " iterations = "+pi);

// Gregory-Leibniz series using a for-loop instead
pi = 0;
for (int i = 0; i < answer && i <= 10000000; i++) {
    pi += ( Math.pow(-1,i) / (2 * i + 1) ) * 4;
}
System.out.println("Pi to "+ loopCount + " iterations = "+pi);
```

Using the Gregory-Leibniz infinite series to calculate Pi in our code.

out.println statement displays the number of loop iterations and our calculated value for Pi.

The loop condition also checks to see if loopCount is less than or equal to 10 million – the reason for this is to ensure a user doesn't enter a huge number that causes the computer lock up while it calculates the series. The double-ampersand (&&) means that both conditions – loopCount being less than answer as well as loopCount being less than or equal to 10 million – must be true for the loop to continue.

That's one way you can write that code. A simpler way is to use a for-loop instead:

```
pi = 0;
for (int i = 0; i < answer &&
i <= 10000000; i++) {
```

```
    pi += ( Math.pow(-1,i) /
(2 * i + 1) ) * 4;
}
System.out.println("Pi to "+
loopCount + " iterations =
"+pi);
```

This not only does the same job as the do-while loop, it saves a couple of lines of code and it's a bit easier to read – and that's important when it comes to code maintenance later on.

We now have the minimum set of tools in our toolbox to start building useful code.

Next month, we ramp things up, starting our look at grouping code together to create functions or 'methods'. ■

The Earthrender downtime

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Warlords of Draenor

Revisit the good old days of *World of Warcraft* in the latest expansion.

Warlords of Draenor is Blizzard going back to its roots, if hardly back to basics. Orcs. Humans. The raw power of the Horde, in a land of blood and fire. It's also some of the best MMO content Blizzard has ever made, combining the raw ambition we saw in *Wrath of the Lich King* with the expertise earned from another six years of practice, refinement and technological progress.

The plot centres on the world of Draenor, before it became Outland as seen in *Burning Crusade*. The evil Warchief Garrosh Hellscream is [insert token and interchangeable MMO plot here].

Anyway, you're now officially one of Azeroth's heavy-hitters. Where once some random guard in a nowhere outpost could have you go get him lunch, now you're given proper respect wherever you go. Soldiers

cheer when they see you approach, and you have full control of your faction's main garrison.

This garrison acts as home for the expansion, but it's also a functioning base. Where once you were piled with meaningless crapwork by uncaring leaders, now you get followers and the power to give them the crapwork – or to have them join you in the field as your bodyguard. As your base grows, you unlock more plots to build on and additional buildings. The whole system is simple but effective, the physical presence of recruited followers and the general sense of life making it feel like your own place despite everyone using the same instanced map. It's a very Blizzard addition.

DRAENOR SHINE

As a setting, Draenor might sound like Outland revisited. In practice, they're worlds apart; same place, very different time. From the ice

and lava of Frostfire Ridge to the overgrown fungus that litters its swamps and the quiet beauty of Shadowmoon Valley, this is a beautiful place. Only Nagrand feels

It's still WoW, though. There are bear arses to collect and ten of what not to kill, and nothing you encounter is going to cause any real trouble. There's no ignoring that it's a game from 2004 and its

"It's still WoW, though. There are bear arses to collect and ten of what not to kill, and nothing you encounter is going to cause any real trouble."

like a return visit, and even that has been given a massive upgrade, with huge cliffs and grass fields.

Throughout the expansion, there's a tacit acceptance that balance in singleplayer PvE is utterly irrelevant, and that players are more likely to stick around if they have a good time. Thus you get a free boost to level 90 to begin with, while levelling is fast, clever and full of fun and variety – in fact I actually felt sad when I dinged 100.

mechanics increasingly creak compared to more modern MMOs, but it still manages to give us a journey that is a triumphant return to form. ■ Richard Cobbett

Verdict

Familiar, but more polished than ever. A powerful reminder of why no MMO has ever taken WoW's rusty crown.





FROM \$79.95 | PC, X360, X1, PS4 | THECREW-GAME.UBI.COM

The Crew

A genre mash of open world racer and MMO grind.

It's a compelling pitch on paper: a sprawling open world racer with the moreish loot and grind dynamics of an MMO. It's a shame that *The Crew* provides a sour opening impression and largely fails to make up for it. You're Some Guy With Attitude, tasked for banal reasons to win a whole bunch of races. In a game primed with the tools to allow players to create their own rules and stories, it feels like a chore to endure this new low for horrendous video game exposition. It's arguably worse than *Need For Speed: The Run*, which is gold standard for torturously bad storytelling in games.

But that's OK, because once you've passed the obligatory tutorial missions the game loosens its grasp on you a bit. You can almost ignore the story. Problem is, the game doesn't get much better. The fundamental problem with *The Crew* is

that the driving isn't fun. The cars do not feel fun to drive, and following the high octane love letter to stupidly powerful land vehicles that was *Forza Horizon 2*, *The Crew* feels like rolling cereal boxes in the dirt. The idea is that you level your cars up via racing, acquiring new components and finely tuning the vehicle's performance, but no amount of fiddling makes minute-to-minute racing any more fun.

Never mind though, because *The Crew*'s notoriously huge approximation of the United States should be pretty fun to explore anyway. The world is very well done, though it's not as beautiful and detailed as, say, *Los Santos*. That can be forgiven because this, after all, is an MMO, and it's much larger than most other open worlds to boot. Exploring it is a lot of fun, though you will have to contend with the cops. They do not make this game

fun or tense, they make it annoying. Escaping the police is annoying in *The Crew*. They make you not want to drive fast, which is a terrible thing to feel in a

crew of friends together, *The Crew* can be a fun multiplayer game if you're not too fussy about handling. Credit has to be given to Ivory Tower for an ambitious (and awesome on

"Following the high octane love letter to stupidly powerful land vehicles that was *Forza Horizon 2*, *The Crew* feels like rolling cereal boxes in the dirt."

game about driving fast cars really fast.

As for the online functionality, it wasn't crash hot at launch but problems seem to be ironed out as of writing. Getting a race can lead to a wait in some of the less popular events, but generally speaking the online connectivity is working fine several weeks after the game's launch. If you can get

paper) concept, but it's far from being a perfect driving game. It only just edges over the adequate line.

■ Shaun Prescott

Verdict

A marvellous concept let down by uninspiring handling and last-gen looks.





Company of Heroes 2: Ardennes Assault

It's an 'Ard life

\$59.95 | PC
COMPANYOFHEROES.COM

What do you do when a Stuka rakes your front line, killing two squads outright and cracking your defences open? Panic. In this standalone single-player campaign for *Company of Heroes 2*, every loss weakens your battalions in future missions. It's a gruelling twist to an RTS that's already as tough as a Panzer's bottom, but it's perfect for a long stretch in the frozen forests of northwest Europe. *Ardennes Assault* puts you in command of three US companies during The Battle Of The Bulge. They will be very familiar to anyone that picked up the *Western Front Armies* expansion earlier this year, but provide more exciting tactical options than the Soviet forces of the core game. Battles are chaotic but well-paced, with less of the overly long attrition missions of the original game, and the heavily forested maps allow for claustrophobic infantry skirmishes as well as tank battles. Every scrap is contextualised by a map view that gives you a choice of engagements. Here your three companies can be improved with 'requisition' earned in battle. Use it to replenish lost forces, or spend it on spectacular air-strikes and troop-drop abilities for deployment in future fights. The company progression rewards are a fun distraction, but *Ardennes Assault* thrives on terrific mission design and a great army. ■ Tom Senior



FROM \$68 | PC, X1, X360, PS3, PS4 | FAR-CRY.UBI.COM

Far Cry 4

Swap sandy beaches for snowy Himalayan mountains.

Ajay Ghale travels to Kyrat, a fictional region of the Himalayas, to scatter his mother's ashes. But by a quirk of fate he finds himself in the service of the Golden Path, an army of freedom fighters founded by his late father. They're locked in a brutal civil war with Pagan Min, the despotic ruler of Kyrat, and it's up to you – the prodigal son – to free it from his tyranny.

It's a neat twist on the classic *Far Cry* setup. You are, as in earlier games, a tourist stranded in an exotic, dangerous place, but this time you have a more personal reason for being there.

Kyrat is a stunning landscape of fog-shrouded mountains, forested valleys, shimmering rivers and rolling plains. The map is large and open, but flanked by towering, snow-capped mountain peaks, and the scenery and atmosphere change subtly as you travel from the lowlands to the highlands. It's just a beautiful place to exist in. It's also an insanely entertaining playground. I've had more fun here than

I ever did in *Far Cry 3*'s tropical archipelago. Kyrat is full of sheer drops, mountains, cliffs and deep valleys. It's remarkably varied and vertiginous, which lets you take full advantage of the new wingsuit and gyrocopters.

Like *Far Cry 3*, the game is split between story missions and outposts. The missions are bombastic, scripted and large-scale, like an absurd action movie, while the outposts give you the opportunity to really play with the game's systems. Both are entertaining in their own way, but it's during outpost raids where things get really good.

There's tonnes of missions scattered around Kyrat. Some of these are fairly standard open-world fare, such as checkpoint races and collectables, but others are worth your time. Map-revealing towers are back, and each presents a unique platforming challenge. There's loads to do.

All of this – barring story missions – can be played with another person in co-op. This is one of the most enjoyable multiplayer experiences I've had for a

while, and having another person on hand when assaulting an outpost only expands the already vast amount of ways to clear them. I didn't experience any issues, but I have heard cases of people being kicked out and losing progress.

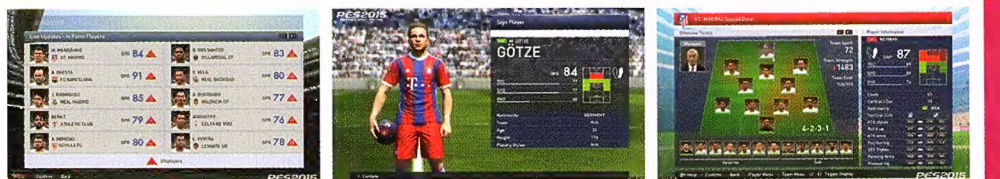
Far Cry 4's biggest weaknesses lie in its scripted missions. Amazingly, despite seemingly everyone hating them, *Assassin's Creed*-style tailing missions have made it into the game. Another issue – but one I quickly got over – is familiarity. *Far Cry 4* is quite obviously an iteration of *Far Cry 3*, rather than any kind of progressive sequel. But then I loved *Far Cry 3*, so I don't care about that. There are more toys to play with, the world is more fun to traverse, the story is infinitely better, and everything just feels tighter and more focused.

■ Andy Kelly

Verdict

An absurdly entertaining open world that's at its best when you break away from its scripted missions.





\$69 | PC, X1, X360, PS3, PS4 | PES.KONAMI.COM

Pro Evolution Soccer 2015

A new generation brings back the qualities of old.

PES' best bits don't lend themselves to the back of a box. Unlike *FIFA*, it can't boast a wealth of stadia, authentic kits or live updates beamed in by a major footballing news site, but that's never been the goal. It saves itself for the pitch – slower, harder and less showy – and this year marks an even greater difference in philosophies.

First off, *PES* needs to be played on the hard setting. Granted, that's an instant turn-off for anyone wanting to go to town with a league-crushing side, but brain-off thrashings waste it. It's not about goals – merely neutralising a rampaging wunderkind or executing a brief flourish are cause for celebration. Sure, you can set game speed on maximum to ape the arcade glory days, but that would be like driving a car in second gear because it goes faster earlier.

No two goals you score are alike. In *FIFA*, you've always got a routine in mind – playing quick one-tvos to set up a chipped through-ball or bombing down the wing are oft-repeated and result in similar strikes. Here, you've got some semblance of a

plan, but matches are more fluid. It can feel haphazard, but that's your brain thinking on its feet, and in replays it always looks like football.

Sides play differently, too. Cautious Atlético Madrid frustrate by stubbornly passing it along the back; Real Madrid get it wide to danger men Ronaldo and Bale; Chelsea play a pressing, oh-God-don't-give-them-a-corner game. Expansive AI does come back to bite, however, because they're damn near infallible. Tackling is almost impossible unless you double or even triple up, most lunges effortlessly evaded with seemingly psychic style. You get the sense they don't play by your rules.

While *PES* closely matches *FIFA* on the pitch, it's leagues behind off it. Master League is particularly disastrous; a humourless mess. Although there's a megalomaniac satisfaction in managing egos, scouting talent and deciding prices, it feels bland, outdated and woefully detached from reality. Seeking to rectify things is Ultimate Team-like MyClub, in which you play matches to earn points and sign superstars, and determine

squad configurations for optimum strength and team spirit, although it suffers from being online-only. This is especially bizarre seeing as how you can face both humans and the computer.

Elsewhere *PES* scores a coup in a suite of officially licensed competitions, including leagues Champions and Europa. Then there's the control-a-single-man Become A Legend, and lastly training exercises. Well, they're more an interactive manual than *FIFA 15*'s series of breezy challenges, and in a sense that sums up what separates the two.

Where *FIFA* aims to look like football, *PES* aims to play like it, and that doesn't just mean scoring great goals – it means learning your squad, facing elite opposition, mastering tactics and grinding out victories. Because in *PES 2015*, the beautiful game isn't always so beautiful.

■ Ben Griffin

Verdict

The on-pitch action is arguably the equal of *FIFA*, but that's far from the only thing that matters.



Lego Batman 3: Beyond Gotham

Bats to the future.

FROM \$68 | WIIU, X1, X360, PS3, PS4
VIDEOGAMES.LEGO.COM

While Batman may have his mug on the box, it's his cohorts who are the real stars of *Beyond Gotham*. Bringing in the dastardly Brainiac and the galactic conflict of the Lantern Corps gives the series a *Guardians Of The Galaxy*-style kick up the backside. Vehicle sections are now handled Resogun-style, with intense rotating battles against enemies such as the Sinestro and the Reach. By 'Resogun-style' I, of course, mean 'complete and utter rip-off', but these bits are still fun and spread out enough to avoid feeling too plagiaristic. Little additions elsewhere make all the difference. Costume pads are no more. The giant 'Lego Big' character sizes from Marvel Super Heroes also make their DC debut, along with huge, multi-stage levels that practically froth with gags and puzzles. Bizarrely, *BG* drops the open-world setup that's made the most recent Lego games such grand experiences. Zooming around Gotham in the Batmobile was a highlight of *Lego Batman 2* and its omission here makes the whole game feel needlessly reductive. So while the absence of an open-world robs some of its sheen, *BG*'s dedication to DC detail makes it a delectable geek feast. Finish the story and you unlock an epilogue based on the wacky '66 TV show. And wait, is that the Arkham Knight Batmobile sitting in the Batcave?

■ Dom Reseigh-Lincoln

Hacked By #GO

Warning :

We've already warned you, and this is just a beginning.
We continue till our request be met.
We've obtained all your internal data including your secrets and
If you don't obey us, we'll release data shown below to the world
Determine what will you do till November the 24th, 11:00 PM(
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Psy breaks YouTube?

In a story that didn't quite create panic amongst all of humanity, YouTube released a statement early in December claiming that Korean popstar Psy's 'Gangnam Style' video had broken the web site's view counter. The company claimed that the infamous video had exceeded 2,147,483,647 views – the maximum number able to be held by a 32-bit integer slot. While many news outlets covered the story in all its glory, Google later revealed that the article was a joke, once again putting faith back into humanity.

Data-collection, now for kids!

After gaining access to the private lives of adults, what better reason than to do the same with kids. A recent report has revealed that billion-dollar company Google is creating new versions of its most well-known products that are specially designed to be used by children. While kid-friendly versions of services such as Google Search and YouTube could be a boon for parents looking to safeguard their young-uns from net nasties, it does raise important privacy questions, such as whether protocols would be put in place to limit the company's ability to obtain minute details about children using the service.

Easy DIY hacking

When is a password not a password? Never!

You'd think that after the notorious 2011 attack on its PlayStation Network – which compromised the account details of some 77 million users – a company as big as Sony would have switched to higher-end security protocols to protect itself from further attacks. However, after its recent hacking (believed to be initiated by North Korean officials in response to the soon-to-be-released comedy film The Interview) it seems that Sony has let its guard down ever so slightly. After the attack, documents were released revealing that the company was storing usernames and passwords for its social media accounts in an unencrypted document that was discretely titled 'Password'. Perhaps Sony hoped the hackers would ignore it for being far too obvious?

Fire extinguisher not included

While the traditional smartwatch enables you to perform simple actions, such as viewing photos or responding to text messages, the Pyro Fireshooter is aiming for something a little different. Inside the wristwatch-sized devices are four barrels, each packing a charge that's capable of launching a fireball up to three metres. Being marketed as the 'must-have' for illusionists, the reasonably-priced US\$174 device is promoted as being safe, although the company strongly encourages users to watch the instructional video before directing the device towards any highly-flammable spectators. ■



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Eftpos Switch

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PC Reset unit

Easy User Installation



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Easy User Installation



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